(2) LEVEL II

AMRL-TR-77-94

ESTABLISHING CRITERIA FOR ASSIGNING PERSONNEL TO AIR FORCE JOBS REQUIRING HEAVY WORK

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TECHNICAL REVIEW AND APPROVAL

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This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

CHARLES BATES, JR.
Chief
Human Engineering Division
Aerospace Medical Research Laboratory

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This report provides a plan which, when executed, will result in an improvement of the Air Force's present capabilities to select and assign personnel to Air Force Specialty Codes (AFSCs). This will be accomplished through the development of a validated objective criterion, as proposed, with which the Air Force can reliably evaluate the compatability of an individual's physical capacities with the physical demands of the various Air Force Specialty Codes.

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The validity of the criterion will be measured by the individual's ability or inability to successfully perform a selected set of well defined demanding tasks within an Air Force Specialty Code.

The method of accomplishment is divided into four phases. Phase I is task oriented. In this phase each AFSC is surveyed to identify the tasks which require significant physical demands. These tasks are quantified, using an appropriate physical unit through the use of task analysis, such that an accurate assessment of the demands can be made. From this list of tasks for each AFSC, a set of tasks known as performance criteria tasks (PCTs) will be selected. An individual's performance on these PCTs will determine whether or not the individual is successful or unsuccessful within that AFSC.

Phase II involves the identification of tests which can be used at the Armed Forces Examination and Enlistment Station (AFEES) and Basic Military Training (BMT) Center for predicting the individual's success within jobs having varied degrees of heavy physical demands.

Phase III involves the definition, hazard evaluation, and procurement of the equipment needed for task analyses, AFEES and BMT testing, and for testing during the longitudinal validation phase (phase IV).

Phase IV involves the finalization and validation of the assignment criteria. Samples of incoming personnel will be tested and categorized according to their tested physical capabilities. The success of these individuals will be monitored over an extended time period (approximately 18 months) such that the AFEES and BMT tests can be validated as successful predictors of success or failure on heavy jobs.

The benefits derived by the Air Force from this capability are a reduction in early discharges due to the inability of the individual to physically qualify for an AFSC after enlistment; a reduction in training costs, both initial and cross-training, due to a reduction in the probability of an individual's eventual failure in the AFSC; a reduction in injury related costs due to a reduction in the number of individuals performing physical demands near or exceeding their maximum safe capability; and a reduction in operating costs by improving the workforce capability relevant to the tasks physical demands.

SUMMARY

This report provides a plan which, when executed, will result in an improvement of the Air Force's present capabilities to select and assign personnel to Air Force Specialty Codes (AFSCs). This will be accomplished through the development of a validated objective criterion, as proposed, with which the Air Force can reliably evaluate the compatability of an individual's physical capacities with the physical demands of the various Air Force Specialty Codes. The validity of the criterion will be measured by the individual's ability or inability to successfully perform a selected set of well defined demanding tasks within an Air Force Specialty Code.

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

I. INTRODUCTION

This report provides a plan which, when executed, will result in an improvement of the Air Force's present capabilities to select and assign personnel to Air Force Specialty Codes (AFSCs). This will be accomplished through the development of a validated objective criterion with which the Air Force can reliably evaluate the compatibility of an individual's physical capacities with the physical demands of the various Air Force Specialty Codes. The validity of the criterion will be measured by the individual's ability or inability to successfully perform a selected set of well defined significantly demanding tasks within an AFSC.

A. OVERVIEW

A brief overview of the conceptualization underlying the proposed methodology for developing the validated objective criterion is presented to facilitate a common understanding of what assumptions and concepts are used and how these assumptions and concepts fit within this proposed methodology.

The capability of the Air Force to select and assign personnel to AFSCs is an important part of the overall effort by the Air Force to effectively coordinate the employment of its personnel.

Fundamental Concepts

There are three fundamental concepts of primary concern within this approach. These concepts are:

(1) A set of physical requirements referred to as the "physical demands" of the various AFSCs,

(2) A set of physical abilities of individuals referred to as "physical capacities," and

(3) The "compatibility" between the physical demands of the various AFSCs and the physical capacities of individuals.

Physical Demands

Within this approach, each AFSC is viewed primarily as having a three tiered organizational structure (Figure 1) wherein the duties can be subdivided into tasks which in turn can be subdivided into elements. For example in the 551X0 career field (Pavements Maintenance) one of the duty categories is to "maintain vegetated areas." That duty consists of tasks such as obtain job order, obtain vehicle, remove mower from storage, obtain gas, check oil-gas, take mower to vehicle, place mower in vehicle, secure mower, obtain personal protective equipment, and mow the vegetation. Each of these tasks can be subdivided into elements; for example, "place mower in vehicle" may require stooping, grasping, lifting, carrying, and placing.

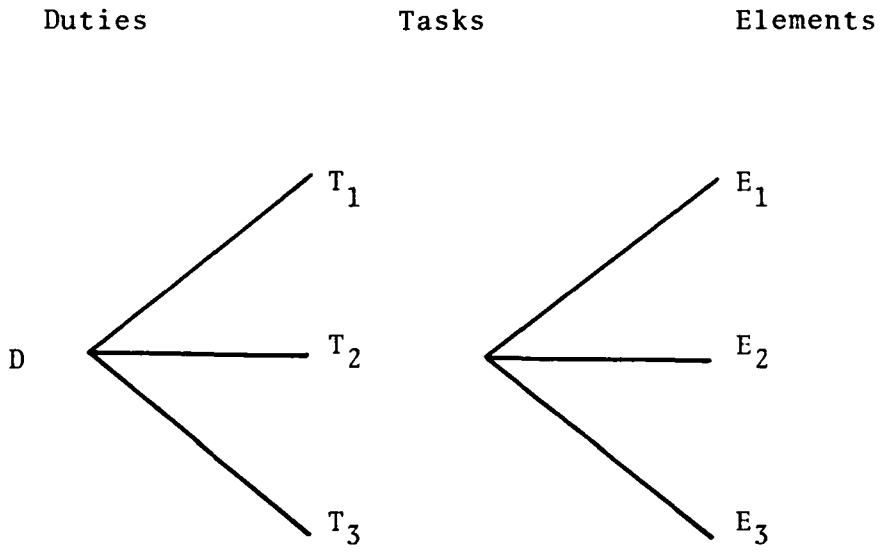

Figure 1. Organizational Structure of an AFSC.

Task quantification will be accomplished at the element level; however, successful performance in an AFSC will be evaluated based on the ability or inability of an individual to perform at the task level. Thus, when reference is made to the physical demands of an AFSC, these demands shall be considered to reside at the task level.

A list of attributes required in describing a particular task is shown in Table 3 (page 34). Many of these attributes will require quantification in order to arrive at the physical demands of the task.

Based on the mini-questionnaire data (see Appendix 1 for details), it is clear that there are several factors which must be considered in the study of physical demands of tasks. These factors are:

(1) Variations in the methods, procedures, and equipment used in task performance,

(2) Variations in the tasks performed within an AFSC as a function of the mission of the unit, and

(3) Variations due to environmental factors.

Physical Capacities

Within this approach the relevant physical attributes of an individual are the individual's physical capacities. The primary physical capacities are the attributes of anthropometry, strength, and endurance (Table 5, page 43). The analysis of the data from the mini-questionnaire (Appendix 1) showed that 90 percent of all physically demanding tasks fall within the category of manual materials handling. This, in effect, if substantiated during the task analyses of the AFSCs, would reduce the number of different primary physical capacities relevant to successful performance.

The Compatibility Between Physical Demands and Physical Capacities

The results of the interaction between a task or a series of tasks and the individual attempting to perform the task or the series of tasks is based on the compatibility of the physical demands of the tasks and the physical capacities of the individual.

In the proposed development of the objective assignment criterion the physical demands of tasks within an AFSC are treated as independent variables. An individual's physical capacities, although independent of the physical demands of an AFSC, are treated as the dependent variables in that they will eventually be treated as such in the selection and assignment processes.

Assumptions

There are four fundamental assumptions which form the basis, not only for the proposed methodology for developing the "assignment

criterion," but also, for the concept that such a criterion may be developed regardless of the methodology.

These assumptions are:

(1) If an individual is physically able to safely perform a given physical task or series of tasks, then the individual possesses the physical capacities necessary to perform the task or series of tasks;

(2) If an individual possesses the physical capacities necessary to safely perform a task or series of tasks, then the individual is capable of performing the tasks;

(3) There is a direct correlation between the ease with which an individual can safely perform a given task or series of tasks and the amount by which the individual's relevant physical capacities exceed the physical demands of the task or series of tasks; and

(4) The physical demands of the AFSCs and the individual's physical capacities remain relatively constant during the period used to validate the criterion.

The first assumption provides the rationale for the eventual selection of incumbents displaying various levels of success in performing the tasks within the AFSCs. The first three assumptions provide the rationale for attempting to establish an objective criterion for assigning individuals to AFSCs. The fourth assumption provides for the stability necessary to properly achieve the validation of the assignment criterion.

B. ORGANIZATION OF THE APPROACH

The methodology for accomplishing the objective of this approach is divided into four phases. Each of these phases and their interrelationships and interdependencies as related to the development of the objective assignment criterion is presented in detail in the TECHNICAL DISCUSSION SECTION of this report. The following is a brief description of these phases.

Phase I. Analysis of Air Force Specialty Codes (AFSCs) to Quantify Tasks Requiring Significant Physical Demands

Phase I deals with the identification and quantification of all tasks across all AFSCs which are found to require "significant" physical demands. A task will be deemed to have significant physical demands if it has mid-range or higher physical requirements according to a 5 or 9 point scale to be developed by the contractor for this specific initial screening of tasks within AFSCs. All tasks which are found to require significant physical demands will be quantified in terms of physical units of power. If this is not possible, other units such as those of static and dynamic strength or energy cost requirements will be used.

From the quantification process of these significantly demanding tasks, one or more distributions, depending on the number of different physical units chosen as appropriate, will be established to represent the physical demands of all AFSCs. It should be noted that these distributions may be adjusted based on possible elimination of tasks from those defined as physically demanding after the detailed analysis and quantification of these tasks are completed. Adjustment of both the lower and upper limits of these distributions will be subject to such change. From the quantified tasks, a set of well defined tasks will be chosen to be representative of the physical demands of an AFSC. These tasks will be used to judge successful and unsuccessful performance among AFSCs. These tasks are referred to as Performance Criteria Tasks (PCTs).

Phase II. Strength/Stamina Aptitude Tests

This phase deals with identification, selection, and measurement of those physical capacities of individuals thought to be pertinent for successful performance of AFSCs having significant physical demands.

The identification and selection of the capacities will be accomplished through the use of Table 5 (page 43). Measurement of the capacities will be accomplished through the use of standard physical capacity tests. The effort in this phase will result in a list of "most likely" candidate tests to be used in phase IV for the development of the "primary" and "secondary" test batteries.

The selection of these candidate tests will be based on the:

(1) Feasibility of accomplishment at the AFEES and BMT center,

(2) Reliability of the test to measure the capacity in question, and

(3) Physical units' compatibility between the task's demands and the individual's physical capacity.

Phase III. Defining Equipment for Strength/Stamina Aptitude Tests and Task Measurement

Within this phase, the identification, testing, and selection of any measurement equipment hardware that may be required within phases I, II, and IV are addressed. The equipment needed in phase I will be used to measure the physical demands of the PCTs, if such direct measurements are needed. The equipment needed in phases II and IV will be used to measure the physical capacities of individual Air Force personnel and/or potential enlistees. Additionally, this latter equipment will be subdivided, as appropriate, according to the primary test battery designed to be administered at the AFEES and a secondary test battery designed to be administered at BMT.

Phase IV. Finalization and Validation of Assignment Criteria

Phase IV includes the finalization and validation of the objective assignment criterion. The finalization of the objective criterion will consist of consolidating and merging the scales of the physical capacities (the dependent variable) with the scales of the physical demands (the independent variable). The resulting criterion will, if at all possible, be expressed as units of power. This criterion will be used to evaluate the physical capacities of test subjects in order to predict success or nonsuccess on an AFSC. The validation procedure will include a longitudinal validation to ensure that the criterion developed can achieve the overall objective of the project.

Figure 2 depicts where and how the various phases fit within the project. Prior to the completion of a phase and progression to a subsequent phase, various validation procedures will be performed. If, as a result of these validations, revisions are required in any of the steps contained within the phase they will be made and the results revalidated. If additional information and/or revisions are required for a previous phase, provisions to reenter the appropriate phases are shown as dotted lines (Figure 2).

To facilitate a common understanding of the interrelationships and interdependencies between the phases, their sections, and the main flow of the project activities, a flow diagram depicting the integration of the entire proposal is presented in Figure 3 and an information flow analysis summary is provided in Appendix 5.

C. ANTICIPATED AREAS OF DIFFICULTY

Potentially difficult areas, anticipated in the course of this study, are briefly discussed below:

1. Physical Demands in Units of Power

Without an analysis of the AFSCs' total job content, it may be difficult to establish the best units to use for measurements of task requirements. However, the units of power denote that the interest is in the rate of doing work with respect to time:

$$\text{POWER} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Force x Distance}}{\text{Time}}$$

Because work is composed of force x distance, a given amount of work can be achieved from high requirements of force coupled with small requirements of distance or vice versa. Therefore, three possible combinations of work can result with some measure: the first is very high force requirements wherein the limiting factor could be strength; the second is the distance involved, hence a limiting factor may be anthropometry; and the third could be requirements of "medium" forces and distances, hence the limiting

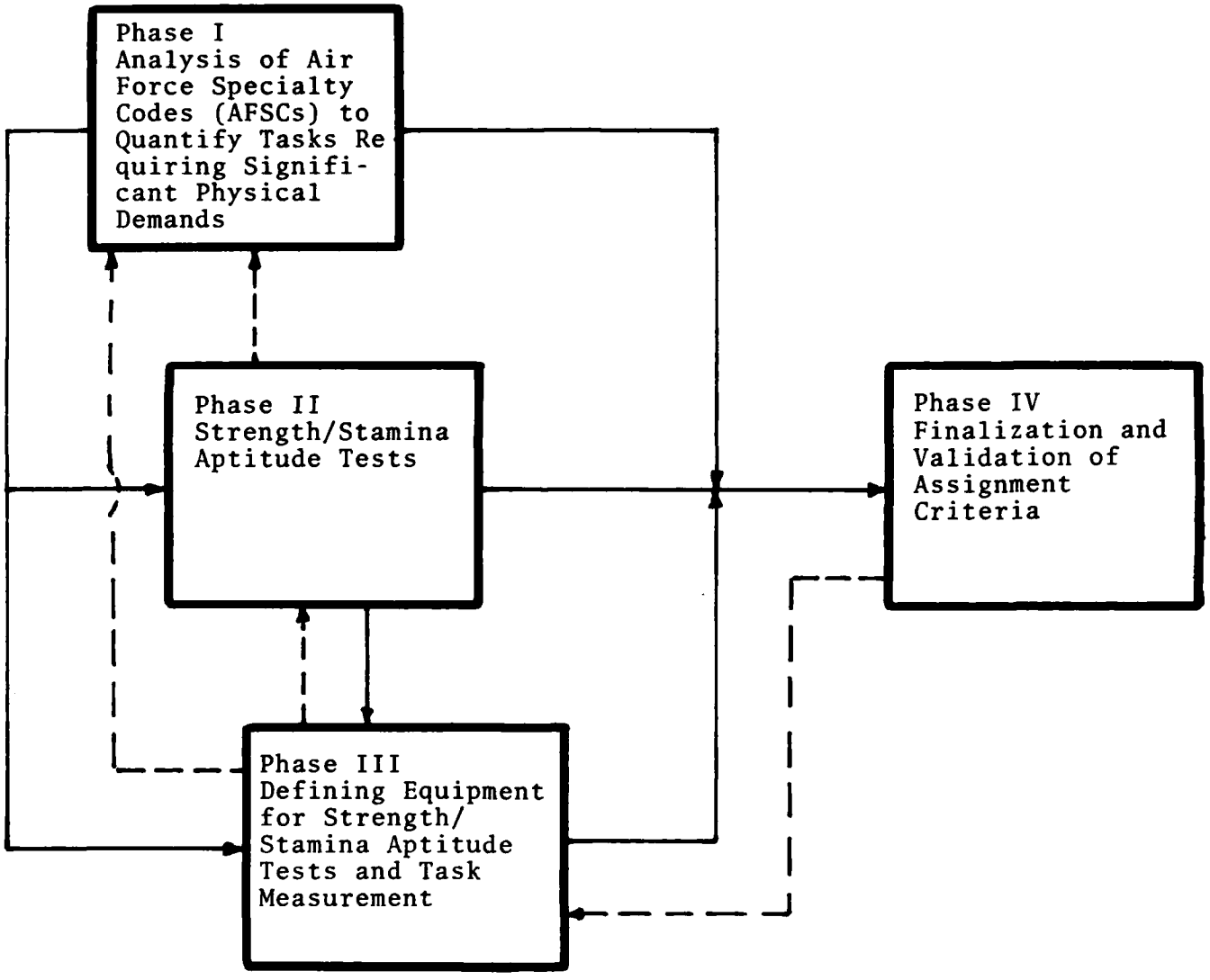

Figure 2. Integration of Proposal Phases

factor could be energy expenditure. Time to complete an element of a task is very important because the rate of change of work is power. Since time is a variable, if the time to complete an element is increased then the power requirements decrease and vice versa.

A serious attempt will be made to use the units of power, however, the analysis of the AFSCs' work, which is proposed to be accomplished in phase I, may establish the best unit for quantification of the physical demands of an AFSC, subject to Air Force approval.

2. The 84 hr/7 Day a Week Schedule

Extrapolation from the 40 hr/5 day per week work schedule to 84 hr/7 day per week may create some problems without conducting experimentation to assess the effects of fatigue and circadian cycles on ability to perform heavy work. If some individuals within the AFSCs are currently working an 84 hr/7 day per week schedule, these should be identified and included in the analysis to ensure that the effects of this schedule can be evaluated.

3. The Variation in Physical Demands of a Task in a Given AFSC

There are major sources of variations in the type of tasks an individual may be expected to perform within an AFSC. These variations may add to the complexity of establishing a standardized and hence a quantitative measure of the physical demands of the AFSC. They may occur due to:

(1) The differences in the types of duties to which an individual may be assigned,

(2) The differences in the types of tasks within the assigned duties and the variety of tasks necessary to accomplish the duties (for example, a review of sample occupation surveys, at the five skill level, indicates that the percentage of incumbent personnel performing within the various "duty categories" range from a low of approximately 3 to 4 percent to a high of approximately 98 to 99 percent). These differences in the types of tasks to be accomplished may be due to the variety of missions (suggested by surveyed Air Force personnel), and

(3) The variations in the physical demands necessary to accomplish a specific task may be due to the differences in the tasks performed due to the available equipment, frequency, duration, environmental conditions, etc. that affect the performance of the tasks.

Consideration should be given to these sources of variation, as well as others, not only in an attempt to quantify the physical demands within an AFSC but also in establishing the identity of PCTs which will be performed by all individuals assigned to an AFSC. These tasks will be used in the evaluation of successful

performance on the job. Although this area may not be difficult to overcome from a measurement point of view,it may have implications on the procedures as well as the "assignment criterion" for personnel. Therefore, it will be necessary to develop a procedure to judge whether or not an individual is successful on a given AFSC. The procedure will be a simple one based on actual observation.

D. SUMMARY OF DEVELOPMENT PROGRAM REQUIREMENTS

The following is not a complete list of requirements for the Development Contractor, but only a summary of the major items.

Phase I. Analysis of Air Force Specialty Codes (AFSCs) to Quantify Tasks Requiring Significant Physical Demands

(1) An operational definition of the levels of physical demands of tasks

(2) A procedure for task analysis and quantification of those tasks which have significant physical demands

(3) Quantification of the demands of all tasks which require "significant" physical demands

(4) Identification of well defined tasks which will be referred to as Performance Criteria Tasks (PCTs)

Phase II. Strength/Stamina Aptitude Tests

(1) Identification of a set of objective tests which can be used to accurately determine an individual's maximum safe physical capability to perform significantly demanding tasks, as defined in phase I

(2) A manual to describe the tests used in the battery, the procedures and equipment required in the administration of the tests, and use of resultant scores. These manuals can be used for training personnel prior to having them administer the test batteries

The Strength/Stamina Aptitude Tests will take into consideration the following factors:

(1) Consistency with the strength and endurance values required as the results of tasks analyses and quantification in phase I,

(2) Upper body strength, lower body strength, and whole body strength,

(3) Present versus potential future physical condition,

(4) AFEES and BMT schedule impacts, and

(5) Test administration in terms of equipment, time, and personnel.

Phase III. Defining Equipment for Strength/Stamina Aptitude Tests and Task Measurement

Provide a list of the test equipment which will be used to:

(1) Measure physical demands of "certain" tasks within AFSCs in phase I, if these demands cannot be obtained through other means (example: push - pull forces),

(2) Measure the physical capacities of individuals during phase II if needed (see Section I.6 in technical discussion, page 37), and

(3) Measure the physical capacities of individuals which will be selected and assigned to heavy work AFSCs during phase IV.

The following factors will be considered in the selection of equipment:

(1) Economic feasibility and reliability of equipment,

(2) Qualifications of equipment operators, and

(3) Safety and human engineering aspects.

Phase IV. Finalization and Validation of Assignment Criteria

(1) An "assignment criterion" (both initial and final) that is to be used to evaluate the physical capacities of personnel to be enlisted and/or reassigned in order to predict success or non-success in heavy jobs

(2) Validation of the analysis of the Initial Assignment Criterion (phase IV) and the Final Assignment Criterion (phase IV)

(3) Documentation of the completed project which will include the Primary and Secondary Test Batteries and a "test manual" for each battery

Validation of the Initial Assignment Criterion will demonstrate that an individual's strength/stamina assessments, as measured by the primary strength/stamina aptitude tests, are within 5 percent of the individual's strength/stamina assessments, as measured by the secondary strength/stamina aptitude tests, and successfully predict an individual's capability to perform work requiring "a certain level of demand" or lower.

Validation of the Final Assignment Criterion will demonstrate that the assignment tests classify individuals according to their ability to perform work with a certain level of demand or lower. This method will demonstrate that 95 percent of the individuals successfully performing tasks classified as requiring a certain level of demand can pass the test with a certain or larger strength assessment, and that 95 percent of the individuals who have not performed successfully on tasks classified as requiring a certain level of demand cannot pass the tests with an equivalent or larger strength/stamina assessment.

II. TECHNICAL DISCUSSION

This section of the report presents the steps and the basic methodology to be used within the project. As mentioned earlier, the project is divided into four major phases. Each of the four phases is further divided into major steps or events proposed as necessary for the accomplishment of that phase.* An input/output data summary is provided for each major step in each phase and integrated into an information flow analysis for the four phases which is contained in Appendix 5. Each of the phase subdivisions, their interactions and interdependencies, is depicted within a flow diagram (Figure 3) and explained in the following narrative.

Phase I. Analysis of Air Force Specialty Codes (AFSCs) to Quantify Tasks Requiring Significant Physical Demands

The primary objective of this phase is the identification and quantification of those tasks requiring significant physical demands. A selected set of these tasks for each AFSC will be utilized, not only as representative of the AFSC's physical demands, but also, as the tasks for determining success or non-success in the AFSC. Success or non-success will be determined by observing whether or not an individual can or cannot perform these selected tasks within given constraints.

I.1 Assembling of Existing AFSCs Task Lists

Several sets of survey data were obtained from Occupational Manpower Research and Development (OMRD) pertaining to several AFSCs. These surveys included relatively current listings of the tasks performed in a given AFSC along with the statistics regarding the percent of individuals performing each task and the percent time spent performing these tasks. Based on the meeting by this contractor with HRL personnel at Brooks AFB, TX, it was learned that similar data for approximately 300 AFSCs are available.

These OMRD/HRL job description surveys will be used as the primary source for assembling task listings for each of the approximately 300 AFSCs. Task listings for the remaining AFSCs, that is, those for which OMRD/HRL job description surveys are not available, will be developed through the use of the following documents:

(1) AFSC job descriptions AFM 39-1,

(2) ATC training manuals available for these AFSCs,

(3) Specialty Training Standards (STS), and

(4) Operational and maintenance manuals.

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*It is realized that in many of the steps discussed under each phase, AF approval may be required. In such steps this approval should be sought with the appropriate lead time.

Phase I. Analysis of Air Force Specialty Codes (AFSCs) to Quantify Tasks Requiring Significant Physical Demands

- I.1: Assembling of Existing AFSCs' Task Lists
- I.2: Development and Administration of Survey Questionnaire to Identify AFSC Tasks Requiring Significant Demands
- I.3: Selection of Tasks Which Have Significant Demands
- I.4: Task Analysis to Develop Detailed Descriptions of AFSC Tasks
- I.5: AFSC Task Quantification in Physical Units
- I.6: Selection of Performance Criteria Tasks (PCTs)

Phase II. Strength/Stamina Aptitude Tests

- II.1: Translate PCTs' Requirements into Physical Capacities Relevant to Successful Task Performance
- II.2: Test Documentation and Inventory
- II.3: Identify Candidate Tests for Inclusion Within Test Battery
- II.4: Administering of Likely Candidate Tests to Sample of Individuals
- II.5: Armed Forces Examination and Enlistment Station (AFEES) and Basic Military Training (BMT) Schedule Analyses

Phase III. Defining Equipment for Strength/Stamina Aptitude Tests and Task Measurement

- III.A: Equipment for the Measurement of Task Demands (Phase I)
  - III.A.1: Define Needed Equipment
  - III.A.2: Perform Preliminary Hazard Analyses
  - III.A.3: Procurement of Equipment
- III.B: Equipment for the Measurement of Physical Capacities (Phase II)
  - III.B.1: Define Needed Equipment
  - III.B.2: Perform Preliminary Hazard Analyses
  - III.B.3: Procurement of Equipment
- III.C: Equipment for the Longitudinal Validation
  - III.C.1: Define Needed Equipment
  - III.C.2: Perform Preliminary Hazard Analyses
  - III.C.3: Procurement of Equipment

Phase IV. Finalization and Validation of the Assignment Criteria

- IV.1: Select Secondary Test Battery-Develop Final Assignment Criterion
- IV.2: Select Primary Test Battery-Develop Initial Assignment Criterion
- IV.3: Location of Test Stations During Validation Period
- IV.4: Conduct Field Studies to Investigate Effect of Basic Military Training (BMT) on Measures of Physical Capacities
- IV.5: Longitudinal Validation of the Assignment Criteria
- IV.6: Document Primary and Secondary Batteries

Final Report

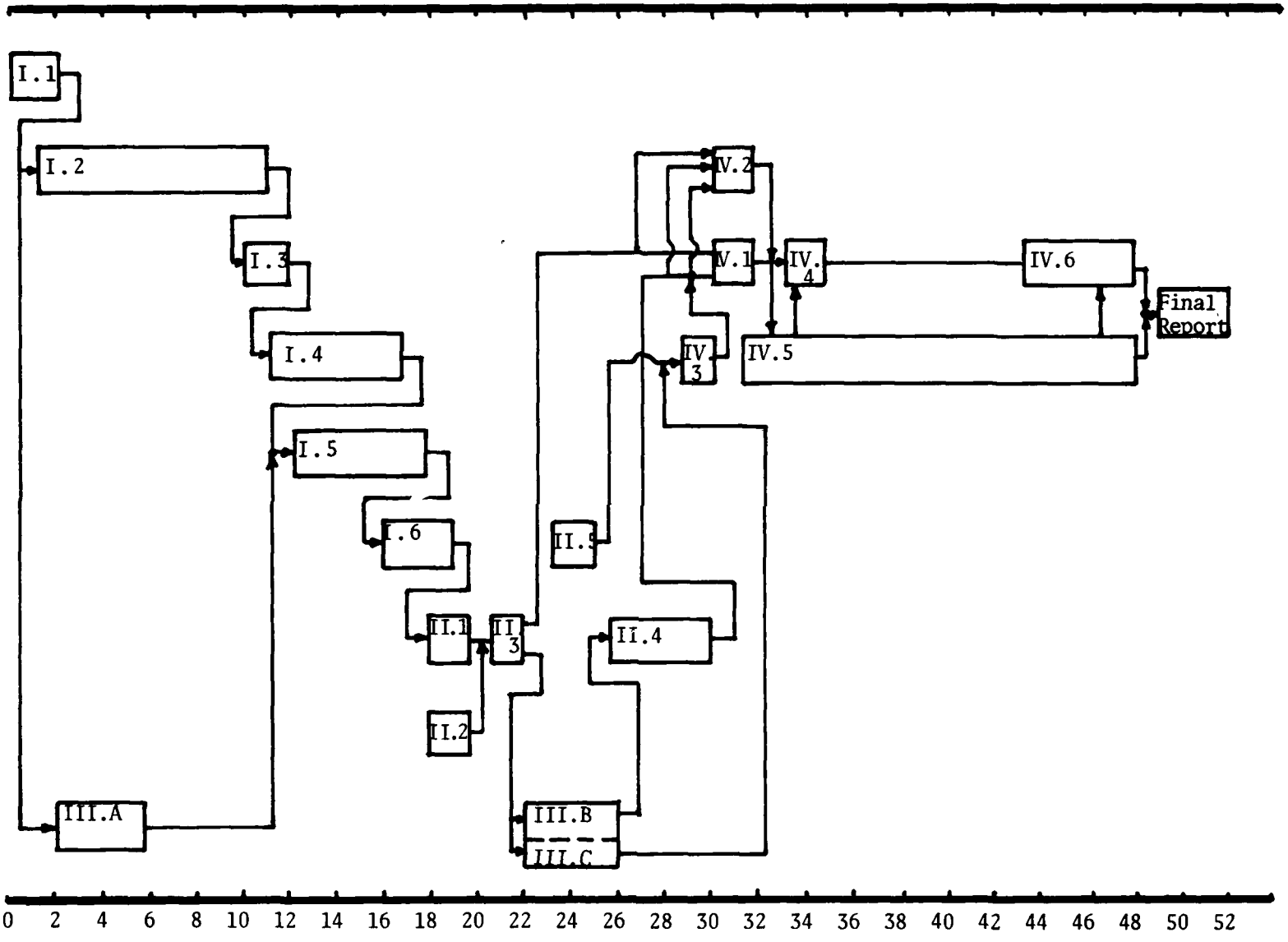

Figure 3. Integrated Flow Diagram (Note: See back cover for loose copy).

These documents will also be used to supplement the information contained in the OMRD/HRL task description surveys.

Input/Output Data Summary

Input data required in this step are:

1. OMRD/HRL job description surveys,
2. AFSC job descriptions, AFM 39-1,
3. ATC training manuals,
4. Specialty Training Standards (STS) including the relevant study references, and
5. Operational and maintenance manuals.

Output data for this step are:

1. Complete task listings for each AFSC.

I.2 Development and Administration of Survey Questionnaire to Identify AFSC Tasks Requiring "Significant" Physical Demands

This major step requires the accomplishment of several substeps. These are:

(1) Development of Operational Definitions for Task Physical Demands,

(2) Development of a Survey Questionnaire, Using the Operational Definitions, to Identify AFSC Tasks Requiring Significant Physical Demands,

(3) Validation of the Survey Questionnaire,

(4) Identification and Selection of a Properly Stratified Sample of Incumbents to Which Survey Questionnaires can be Administered, and

(5) Administration of the Survey Questionnaire and Identification of the Significantly Demanding Tasks.

A description of each of these substeps is as follows:

(1) Development of Operational Definitions for the Levels of Task Physical Demands Using Available Literature

In order to initially assess the degree of physical demands of tasks within the AFSCs, an operational definition of physical demands against which tasks may be rated as to their level of

physical demand will be developed. This operational scale will be divided into five or nine levels covering the entire range of physical demands. Several operational definitions of levels of task physical demands have appeared in the literature in addition to the one used by the Air Force. Some of these are presented in Table 1.

The five or nine point operational definition scale (HRL has used nine point scales) will have each point on the scale defined by a narrative description. These descriptions will include quantitative values of physical task demands representative of that level with an emphasis on manual materials handling type requirements. The emphasis on manual materials handling is based on the results of the "mini-questionnaire" (see Appendix 1) survey performed by this contractor. These results indicate that 90 percent of all the difficult tasks performed at the two bases used in the administration of the mini-questionnaire were in the manual materials handling category. It should be noted that most of the scales provided in Table 1 do utilize manual materials handling tasks as the basis for their narrative description.

An operational definition of the levels of task physical demands applied across all AFSCs can be placed on this scale to initially reflect their levels of physical demand as well as their ranges.

This operational scale will be utilized solely to perform the initial screening of tasks across all AFSCs to establish their relative physical demands. Once the tasks have been categorized in accordance with the operational definitions and the physically significantly demanding tasks have been identified, the operational definitions will have served their purpose. Therefore, these operational definitions will not be further needed. Those tasks found to have "significant" demands will be analyzed in detail, including quantification using the appropriate units, in a later step of this phase.

(2) Development of a Survey Questionnaire Using the Operational Definitions, to Identify AFSC Tasks Requiring Significant Physical Demands

Task physical demands for each AFSC will be compared against the operationally defined scale through the use of a survey questionnaire administered to incumbents. Table 2 shows a suggested survey format.

The proposed questionnaire will be developed by the contractor in cooperation with HRL and will be tested for reliability and validity.

(3) Reliability of the Survey Questionnaire

After the development of the survey questionnaire the validity and reliability within and across AFSCs will be tested prior to administration. See Appendix 2 for these procedures.

TABLE 1

SAMPLE OPERATIONAL DEFINITIONS

A. Work Classification according to: Air Force Manual 39-1. Airman Classification Manual, 1969.

Sedentary Work

Lifting 10 pounds maximum and occasionally lifting or carrying such articles as dockets, ledgers, and small tools. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are sedentary if walking and standing are required only occasionally and other sedentary criteria are met.

Light Work

Lifting 20 pounds maximum with frequent lifting or carrying of objects weighing up to 10 pounds. Even though the weight lifted may be only a negligible amount, a job is in this category when it requires walking or standing to a significant degree, or when it involves sitting most of the time with a degree of pushing and pulling of arm or leg controls.

Medium Work

Lifting 50 pounds maximum with frequent lifting or carrying of objects weighting up to 25 pounds.

Heavy Work

Lifting 100 pounds maximum with frequent lifting or carrying of objects weighing up to 50 pounds.

Very Heavy Work

Lifting objects in excess of 100 pounds with frequent lifting or carrying of objects weighing 50 pounds or more.

TABLE 1 -- Continued

B. Work Classification according to: Kamon and Goldfus, 1977.

1. Very Heavy - included jobs in which it was necessary to lift objects weighing 23 to 34 kgs. as much as ten times in one hour, and between 35 and 50 kgs. at least once a week. Carrying these weights short distances was also necessary. Some jobs required pulling forces of 75 kgs. (via pully system) from a stooped position.

2. Heavy - consisted of jobs where lifting of up to 23 kgs. of weights was required as much as three times per hour. In addition, some jobs required the application of pushing force of 20 kgs., 20 times an hour and the use of a wheelbarrow twice an hour to carry weights of up to 34 kgs.

3. Moderate - included duties requiring lifting of 12-15 kgs. or less. Much of this included lifting objects from a waist height to shelves at head height. This category also included janitorial work.

4. Light - included duties requiring minimal physical strength. This category included doctors, nurses, engineers, supervisors and clerical workers.

TABLE 1 -- Continued

C. Work Classification according to: Larson, 1974.

Sedentary Work

School work, office work, drawing, weaving, and so on.

Light Work

Housework, laboratory work, panel operators, dispatchers, crane operators, handling of transport means (without loading), assembly work, picking hops by hand, and so on.

Medium-Light to Medium-Heavy work

Work carried out in industry and agriculture on machines; alternately sitting, standing, and possibly walking for exercise, machine ploughing and harvesting, mechanized work (cutting with power saw), mechanized work in the mines, work on heavier machine tools, assembly of heavy objects, machine forging, transport of medium-heavy loads for a short distance.

Heavy Work

Work carried out by large muscle groups during prolonged periods, loading and transport of heavy loads (for example, carrying meat at the slaughterhouse, carrying of sacks, loading wood by hand) wood cutting in the forest by hand tools, agricultural work in mountain regions, grain harvesting by hand, manual work in the mines, timbering in the mines, work with the pneumatic pick, excavation by hand, and so on.

TABLE 2

SAMPLE SURVEY*

ESTABLISHMENT OF RANGE AND DISTRIBUTION
OF PHYSICAL DEMANDS OF AFSCs

	Do you perform this task?		What % of your time is spent on this task?	Levels of Physical Demands				
				Level 1	Level 2	Level 3	Level 4	Level 5
Listings	y	N						
[obtain from OMRD/HRL surveys and other documents]								

Respondent Identification Section

AFSC Identification Section

Summary Description of Levels

Level 1
Level 2
Level 3
Level 4
Level 5

*A set of instructions will accompany this survey; this format reflects the type of information sought rather than form of questions or presentations of questionnaire to solicit the appropriate response.

The validation of the survey will be accomplished by testing the questionnaire responses for a sample of tasks against the actual task physical demands, whereas, the questionnaire reliability will be tested using analysis of variance techniques (see Appendix 2).

(4) Identification and Selection of a Properly Stratified Sample of Incumbents to Which the Survey Questionnaire will be Administered

Incumbents from the field (more than one incumbent/AFSC) can best apply the operational scale to the tasks for each AFSC using a survey questionnaire.

The survey questionnaire will be administered to a sample of incumbents assigned to the various AFSCs. Incumbents at the 5 or 7 skill level can best categorize the tasks in accordance with the operational definitions. This sample of incumbents (more than one incumbent/AFSC) will be stratified into the following important strata:

(a) Incumbents from different Air Force bases having identical missions,

(b) Incumbents from different bases having different missions to represent ATC, MAC, SAC missions, etc., and

(c) Incumbents from different geographical regions to account for varied environmental conditions.

In order to achieve this stratification, it will be necessary to obtain data regarding the AFSCs for each command for each base and the number of individuals employed per AFSC per command and again per location. Unless otherwise warranted by additional information obtained and/or other constraints encountered, five or more incumbents per AFSC from each Air Force base used will be utilized in the sample.

The objective of a stratified sample is to enable the contractor to perform standard statistical tests to test for:

(a) Differences between AFSCs' requirements due to different methods and/or tools used in performing the same tasks,

(b) Differences between AFSCs' requirements due to variation in equipment utilized, and

(c) Differences in physical demands of tasks and/or stresses on the individual due to severe environmental conditions.

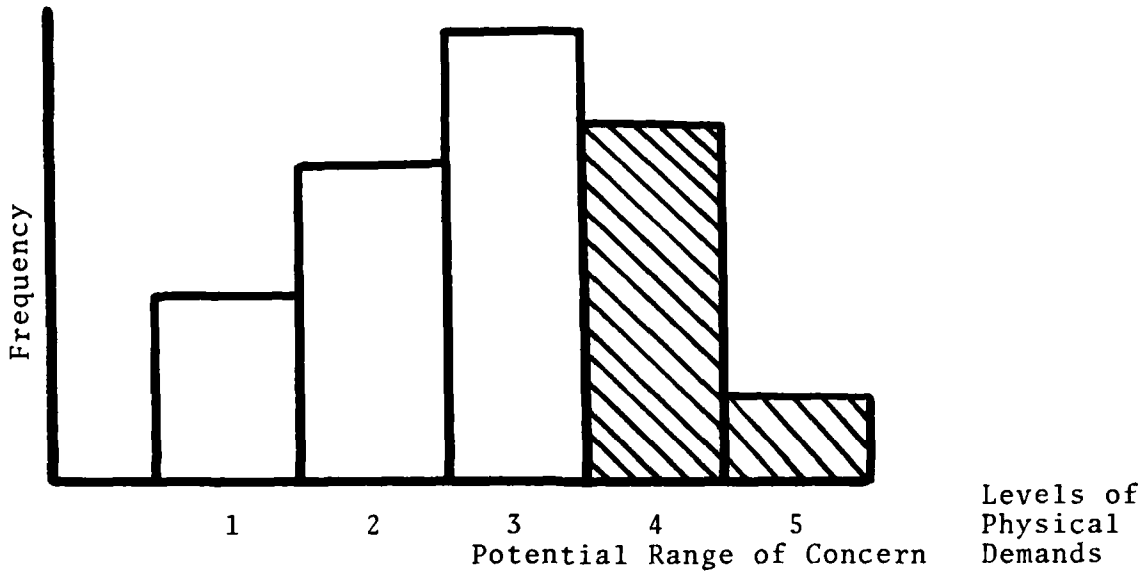

Figure 4. Histogram Showing the Range and Distribution of Demanding Tasks According to 5 Point Scale of Physical Demands.

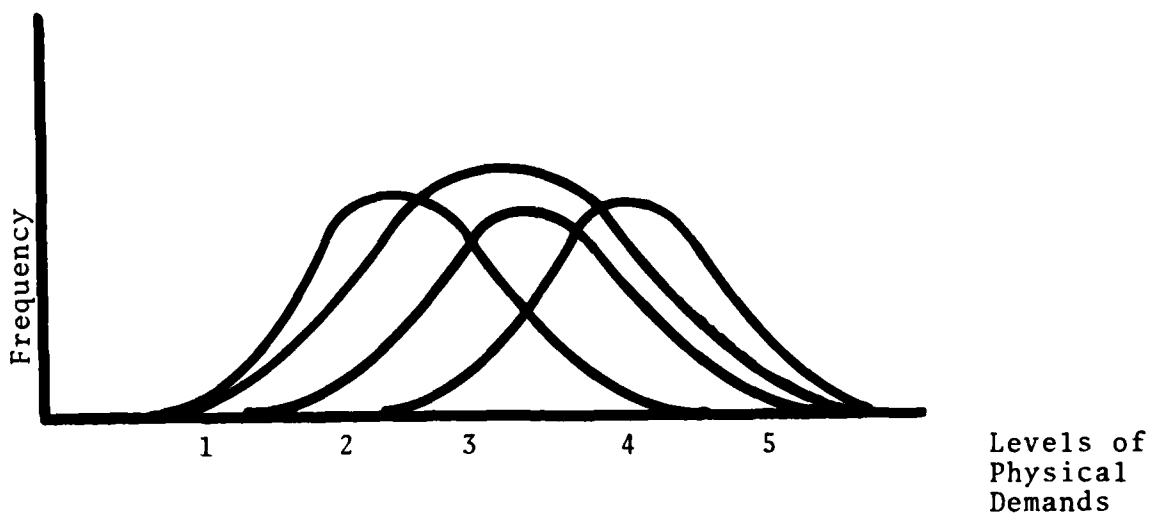

Figure 5. Sample Distributions of AFSCs' Tasks According to the 5 Point Scale of Physical Demands.

(5) Administration of the Survey Questionnaire and Identification of the Significantly Demanding Tasks

The survey will be administered to the selected sample of incumbents and graded. The results of this questionnaire will be used to categorize the tasks in accordance with an initial range and distribution of the task demands within each of these AFSCs. Figure 4 shows a possible range and distribution of the tasks for an AFSC with varying physical demands according to the operational scale.

It is anticipated that all AFSCs as a group will have a wide range of physical demands. Some of these AFSCs may have physical demands that may be clustered in the upper range, some may be clustered toward the lower range, while others may be clustered in the middle of the range of the operational scale. Other AFSCs may be distributed such that they cover the entire range of the operational scale (Figure 5).

Input/Output Data Summary

Input data required are:

1. Task listing from step I.1 for all AFSCs obtained through job survey and/or other documents,

2. Data on 5 and 7 skill level incumbents regarding number available in each AFSC, by base, by sex, and by length of service. This data will provide the necessary base for sample selection and stratification for questionnaire administration, and

3. Available literature information and data for the operational scale development.

Output data from this step are:

1. A 5 or 9 point operational scale with narrative describing the demands for each level,

2. A machine gradable questionnaire to be administered to field incumbents for the purpose of initial screening of AFSCs tasks which have significant physical demands,

3. Questionnaire reliability and validation check,

4. Incumbent sample identification and selection, and

5. Tabulated survey questionnaire results and statistical analysis of these data.

I.3 Selection of Tasks Which Have "Significant" Physical Demands

From the questionnaire results in I.2, all AFSC tasks which have been identified to have physical demands equivalent to or less than level 2 of the operational scale will be considered to have non-significant physical demands. Tasks having demands equivalent to or greater than level 3 are likely to have significant physical demands. Therefore, these tasks with demands equivalent to or greater than level 3 will be subjected to a detailed task analysis which will result in further screening out of any non-significant tasks.

Since level 3 of the operational scale is the mid-range, it may include tasks with significant demands. Therefore, level 3 was included with the higher levels to ensure the inclusion of all tasks with significant demands. All tasks which have demands equivalent to or greater than level 3 on the operational scale will be considered as tasks which have significant demands. Further screening of these tasks will be accomplished in step I.4 to identify any tasks which have been misclassified.

During this step, the contractor, using the statistical analyses of the questionnaire data in I.2, will identify those AFSCs as well as their tasks which may have varied requirements because of the following factors:

(1) Mission orientation,

(2) Methods and practices of task performance, and

(3) Environmental conditions.

If significant differences between tasks' demands are found due to the above mentioned factors, the contractor will identify and record the differences in demands for use in the task analysis and quantification steps (I.4 and I.5). These differences will be identified by using the statistical procedures discussed in Appendix 2.

Input/Output Data Summary

Input data required are:

1. Tabulated survey questionnaire results and statistical analysis of step I.2, and

2. AFSC data regarding utilization per major command, geographical location and number of individuals employed per command and per location.

Output data from this step are:

1. A list of tasks across all AFSCs which have been identified as likely to have significant physical demands, and

2. Identification of those tasks, hence AFSCs, which differ significantly in their demands within an AFSC due to factors of mission orientation, environment, and/or methods and equipment used in task performance.

I.4 Task Analysis to Develop Detailed Descriptions of AFSC Tasks

A detailed task analysis of each task identified in I.3 as likely to have significant physical demands will be performed in order to develop a quantifiable description of that task. Detailed descriptions of these tasks will then be developed for the purposes of identifying the elemental breakdown of the significantly demanding tasks for subsequent quantification.

Task analysis will be accomplished through the use of training manuals, operational and maintenance manuals, training films, task performance observation, and personal interviews of incumbent personnel. The objective is to subdivide each task into its elements such that activities, equipment, tools, materials handling, and methods of performance of each element can be isolated and described with the appropriate performance times.

It is recognized that the AFSCs are not equally structured, hence, it will be necessary to utilize a more active approach for gathering the descriptive information. That is, it will be necessary to employ the use of task performance observation and personal interviews. The available manuals will serve as an input to develop the structured interviews with the incumbents and assist in identifying the specific AFSCs which may require observation.

A sample of incumbents who participated in step I.3 will be interviewed by the contractor. These interviews and observations of task performance will be used to validate the significantly demanding tasks identified using the questionnaire in I.3. Those tasks which are found to have demands less than those defined by level 3 of the operational scales will be screened out as a result of these procedures.

The development of the task descriptions and their validation will be coordinated with the task quantification. In this way unnecessary redundant activities may be avoided such as collecting data concerning weights, sizes, shapes, and forces applied during the course of task performance.

Input/Output Data Summary

Input data required are:

1. A listing of significantly physically demanding tasks as compiled from the questionnaire responses, and

2. Data from training manuals, operational and maintenance manuals, training films, task performance observations, and personal interviews.

Output data from this step are:

1. Validated detailed elemental task descriptions of those tasks identified as being significantly physically demanding. The description will consist of an elemental breakdown to include postures, tools, equipment, materials handled, and methods used, and time required to perform these task elements.

I.5 AFSC Task Quantification in Physical Units

Task quantification will be accomplished concurrently with the development of detailed task descriptions. Quantification data will be obtained from training, operational, maintenance, equipment, and supply manuals, training films, task performance observation, task measurement, and structured personal interviews of incumbents assigned to these AFSCs. These analyses will provide the following essential data:

(1) Complete method descriptions of elemental task performance including estimates of distances involved and movements made,

(2) Complete quantitative listings of material, equipment, and tools used including size, shape, weight, etc.,

(3) Frequency of and time for task/element performance,

(4) Estimates of forces required in performance of each of the task elements both in magnitude and direction including any torquing requirements, and

(5) Body position (posture) during performance of each element of the task and segments of the body involved.

Table 3 is a comprehensive breakdown of the data which is required to complete the quantification process and to provide additional data (non-quantifiable) which will be needed for assessing the effects of posture, equipment, and task complexity on the demands of these task elements.

TABLE 3

SUMMARY OF JOB REQUIREMENTS AND STRESSES BY TASK FOR THE PURPOSE OF QUANTIFICATION, EVALUATION**, AND/OR RANKING

	QUANTITATIVE PARAMETERS																																
	Temporal								Forces																						Load		
			Work Practices						Lift or Lower			Push			Pull			Carry or Hold			Torque			Other								
			Shift			Rest Periods																											
Task Performed Task Element	Frequency (#/time)	Duration (time)	Fixed Period (Hours)	Rotating Number Hours	Cycle	When	Length	Group Size (number of helpers)	Amount (lbs. force)	Start Position (inches)	End Position (inches)	Amount (lbs. force)	Distance (ft)	Time (min)	Amount (lbs. force)	Distance (ft)	Time (min)	Amount (lbs. force)	Distance (ft)	Time (min)	Amount (lbs. force)	Rotation (degrees-direct)	Crank(Revolutions-direct)	Type	Amount (lbs. force)	Distance (ft)	Time (min)	Weight (lbs)	CG Location (inches) (Distance front body)				
1. (Task title)																																	
a (element title)																																	
b																																	
c																																	
.																																	
.																																	
.																																	
2. (Task title)																																	
a																																	
b																																	
c																																	
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.																																	
.																																	

TABLE 3 Cont.

Load						Posture							Equipment			Work Place			Environment										
Dimensions				Handles						Other				Personal Protective Mobility Restriction															
Height (in)	Depth (in)	Length (in)	Diameter (in)	Handle Dia (in)	Handle Length (in) (Location)	Stand Time (min)	Sit Time (min)	Kneel Time (min)	Other	Type	Time (min)	Distance (ft)	Tool Weight (lbs)	Movement (%)	Speed (%)	Height (in)	Width (in)	Depth (in)	Temperature (°F)	Rel. Humidity (%)	Wind (mph)	Dust (ppm)	Noise (dba)	Vibration (cps)	Rain (in/hr)	Pollution (index #)	Snow (in/hr)	

TABLE 3 Cont.

NON-QUANTITATIVE PARAMETERS										
Equipment										
Tools				Personal Protective			Power $\frac{\text{Force x Dist}}{t}$	Force x time	Comments	
Type	Power	Hand: One	Hand: Two	Truck - Head	Upper Ext.	Lower Ext.				

* Not final or exhaustive table. Changes, including degree of detail, will be made, after the tasks have been identified for the finalized task analysis.

** Not all pertinent items can or will be "absolutely" quantified.

Tasks having significant strength demands are divided into dynamic and static components. The contributions of the two vary considerably depending on the nature of the task. The unit of power will be used to evaluate the dynamic components while the static components will be evaluated using force x time units. Other units which may be appropriate will be considered when the task analyses are completed.

Input/Output Data Summary

Input data required are:

1. Task analysis data obtained from the various manuals, observation of the tasks, and interviews.

Output data from this step are:

1. Task quantification at the element level using Table 3 to arrive at task demands in terms of units of power and/or other appropriate units, and

2. Task variables which contribute to the physical demands of the task such as posture imposed.

I.6 Selection of Performance Criteria Tasks (PCTs)

In order to evaluate the performance of individuals assigned to an AFSC it is essential that tasks be selected which are representative of the physical demands of that AFSC. These tasks must be well defined in terms of the levels of demand, the methods of their performance, the tools and equipment used, the conditions under which these tasks are to be performed, and the time required to perform these tasks. In this way it will be possible to judge if an individual can successfully perform these tasks within the specified time using standard methods and equipment. These well-defined tasks will also be chosen to be representative of the level of demand of each AFSC. These tasks are those defined as Performance Criteria Tasks (PCTs).

Since the assignment of personnel to jobs in the Air Force will be based on the ability of an individual to perform jobs having varied degrees of heavy demands, it is necessary to divide the total range of physical demands for the tasks quantified in I.5, into percentiles. These percentiles will be used to identify ranges which correspond to several demands.

Figure 6 shows the range and distribution of the significantly demanding tasks using the unit of power (ft lb/min). Based on energy consumption data shown in Table 4, heavy work requires 7.5-9.9 kcal/min, while very heavy work requires 10.0-12.4 kcal/min. These values are equivalent to 465-613 ft lb/min for heavy work and 620-768 ft lb/min for very heavy work when the common 20 percent efficiency is utilized for human work. Using these

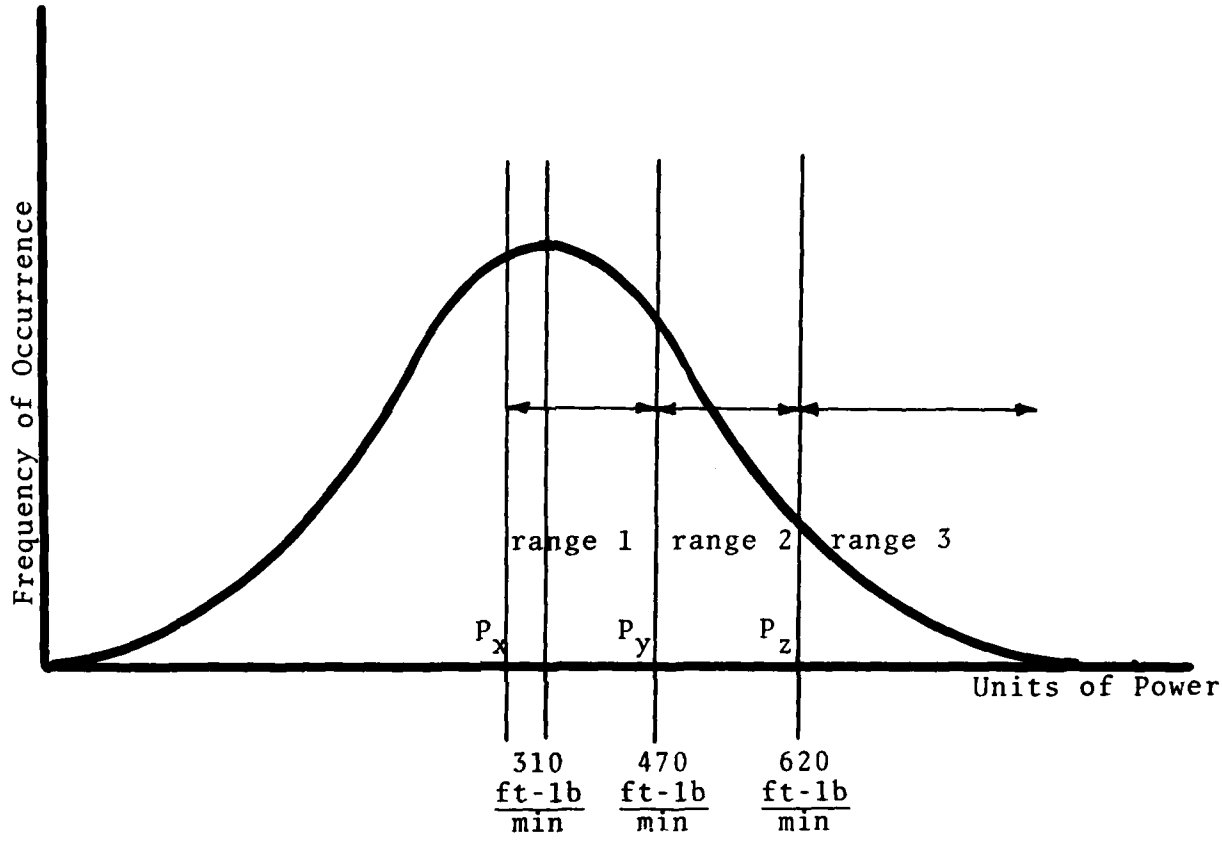

Figure 6. Example Distribution of the Level of Demand of all Significantly Demanding Tasks Across all AFSCs.

values as guides, it is possible, as shown in Figure 6 to divide the demands of the tasks into three percentile values, P_x, P_y and P_z. These percentile values can be used to establish as many as three degrees of heavy work.

If other scales, in addition to or in place of one for power, such as static strength, are used, similar approaches will be utilized whereby individual capacities will be considered in relation to work demands to arrive at rational percentile ranges for several degrees of heavy work demands.

TABLE 4

GRADING SYSTEM FOR INDUSTRIAL WORK*

	Energy Consumption kcal/min	Equivalent ft lb/min
Light	2.0 - 4.9	124 - 304
Moderate	5.0 - 7.4	310 - 459
Heavy	7.4 - 9.9	465 - 613
Very Heavy	10.0 -12.4	620 - 768
Unduly Heavy	12.5 -	775 -

*Source: Durnin and Passmore, 1967.

Once the ranges of demand for the quantified tasks have been delineated, the process of selecting a set of tasks which may be representative of the level of demand for each AFSC will begin. The following steps will be followed to lead to the selection of PCTs for each AFSC.

1. Based on the ranges which represent the degree of heavy work in Figure 6, all quantified tasks falling in these three ranges will be considered in subsequent steps. If two ranges instead of three should be considered at a later time, the same approach will still be applied.

2. From OMRD/HRL and the survey questionnaire the following data will be available:

   (a) number of individuals performing each task in the identified range of heavy work, and

   (b) percent of time spent in each task in the range of heavy work.

3. One approach would be to use the data of 2(a) and 2(b) to establish a weighted function 'G'. A distribution of the heavy demanding tasks for each AFSC will be constructed as shown in Figure 7. Figure 7 represents

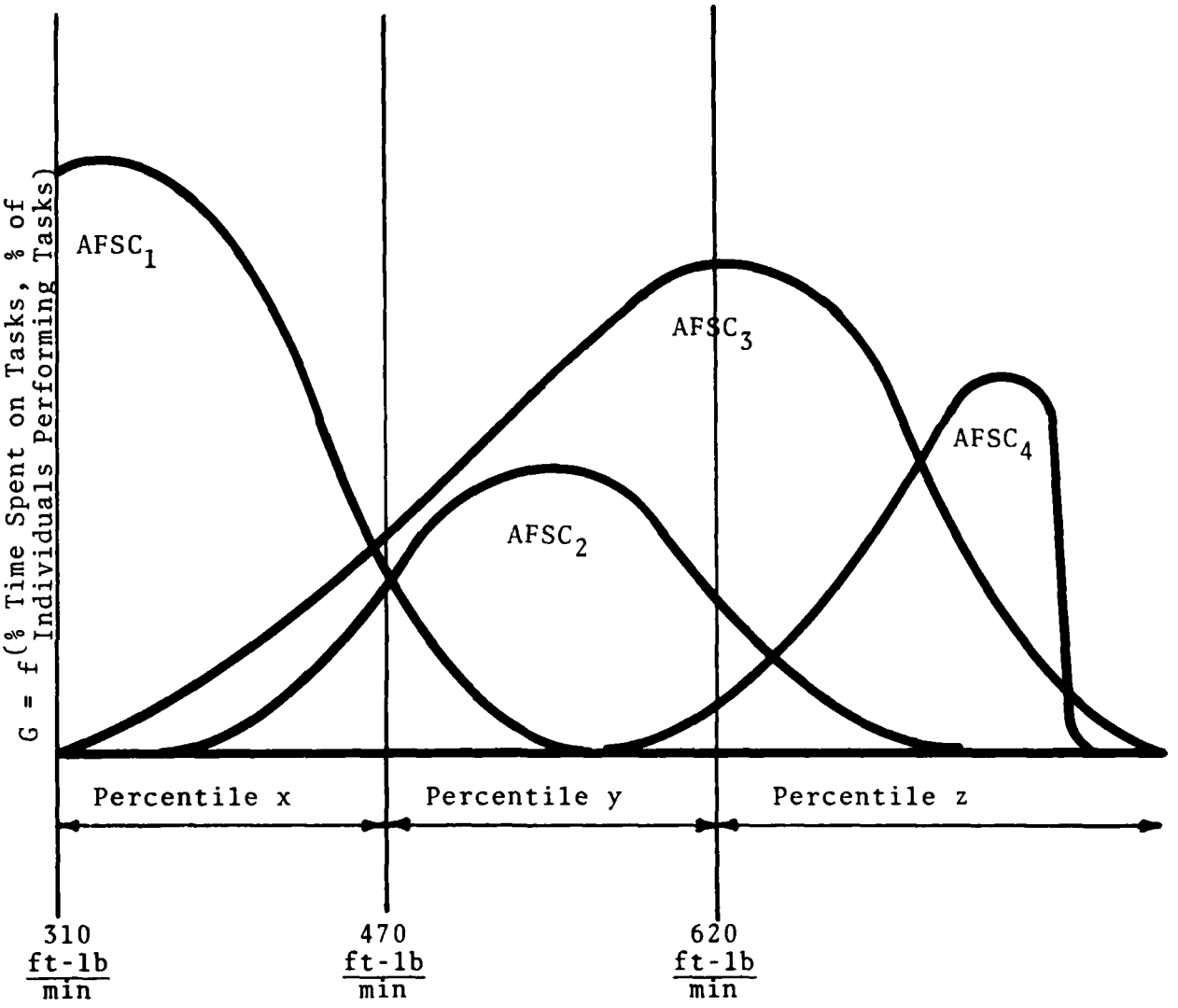

Figure 7. Distribution of Task Demands per AFSC vs. G, a Function of Percent Time Spent on Task and Percent of Individuals Performing the Task.

the segment of Figure 6 for tasks representing demands of 310 ft lb/min or higher. Each AFSCs' distribution of task demands using the weighted function G will be constructed as shown in Figure 7 as given by $AFSC_1$, $AFSC_2$, $AFSC_3$, and $AFSC_4$. For each of these AFSCs, the mode value on the demand scale will be used as the most representative value for the demand level of that AFSC. The mode value will be most representative in that it will be a function of the percentages of individuals and the percentage time those individuals spend performing the task demand at that point. The tasks which fall within ±10 percent of this demand value will be declared as likely candidates for the PCTs. At the same time the relative position of the mode will establish whether an AFSC is considered heavier than another in terms of physical demands. All likely candidates for PCTs will be re-examined to ensure accurate elemental analysis and quantification prior to proceeding with step 4.

4. After step 3, all likely candidates for PCTs will be finalized and available for inspection. The purpose of the inspection is to identify the various types of physical activities that are required by these elements. For example, elements which require manual materials handling activities will be considered as a single type, while elements which require torquing will be considered another type, etc.

   The objective of identifying these types is to establish the number of possible types into which these representative tasks (PCTs) can be divided. It is highly likely, based on the mini-questionnaire, (See Appendix 1) that most of the PCTs will be of 1 or 2 types such as manual materials handling and/or torquing. If this is the case, it is advantageous to simulate these task elements instead of using the actual PCTs for both the strength/stamina battery development and the demonstration of successful performance on an AFSC. This alternative is recommended and will be referred to as alternative 1.

   If, however, the types of PCTs are many, the procedure will be to identify "several" PCTs which fall within ±10 percent of the mode value of the demand for that AFSC and which also may require different individual characteristics such as strength, stamina, etc. These PCTs, selected as representative of each AFSC requiring heavy levels of demand, will be further considered for the development of the strength/stamina batteries and the evaluation of success or failure on an AFSC.

   This is alternative 2 and will be used in the event alternative 1 cannot be implemented because the number of types of tasks and their nature is such that they cannot be simulated.

Input/Output Data Summary

Input data required are:

1. Quantified tasks, for each AFSC, which have been identified as having significant demands, and

2. The percent time spent performing each task and the percent of individuals performing these tasks.

Output data from this step are:

1. Performance criteria tasks (PCTs) which are representative of the demands of the AFSCs. These tasks will be used to determine an individual's success within the appropriate AFSC.

Phase II. Strength/Stamina Aptitude Tests

This phase is concerned with the identification of objective tests which can be used to evaluate an individual's maximum safe physical capability to perform heavy work. These tests will be selected to measure individual physical capacities identified as being relevant to successful task performance based on the task requirements determined in phase I.

The physical capacity levels will be in the ranges of strength/stamina that are consistent with the quantities of strength/stamina required during the analysis and quantification of the PCTs in phase I.

II.1 Translate PCTs' Requirements into Physical Capacities Relevant to Successful Task Performance

The task analysis conducted in phase I will have identified the details of physical demands of the PCTs and will provide the data on the range of physical demands of these PCTs within each AFSC. The data for each PCT will then be retabulated (in a format similar to Table 5) to correspond with the relevant physical capacities. In retabulating the data concerning the physical demands of the PCTs, careful consideration will be given to the relevant physical capacities, body segments involved, types of postures and movements, etc. required in performing the PCTs.

A computer analysis of these data will be conducted in order to provide information on the physical capacities (static and dynamic strength, aerobic power, etc.) relevant to successful task performance. The physical capacities will be expressed as a function of:

(1) The major body segments involved (upper, lower, and trunk),

TABLE 5

SUMMARY OF HUMAN PHYSICAL CAPACITIES RELEVANT TO TASK PERFORMANCE

Task Identification Code AFSC Number H/VH Work/Other XXX XX	Task Properties				Body Segment							Type of Action					Posture					Individual Capacities				
					Upper Extremity			Lower Extremity			Trunk															
	External Weight	Force Required	Duration of Task	Repetition Rate	Shoulder	Arm	Hand	Hip	Leg	Foot		Flexion	Extension	Abduction	Adduction	Rotation	Standing	Sitting	Prone	Supine	Other	Static Strength	Dynamic Strength	Aerobic Power	Anaerobic Power	Explosive Power
XXXXX-XXX-XX																										
XXXXX-XXX-XX																										
XXXXX-XXX-XX																										

(2) The types of movements involved (flexion, extension, etc.), and

(3) The types of posture involved (standing, sitting, walking, etc.),

while considering the following task properties:

(1) External weights,

(2) Forces required,

(3) Duration in performing tasks (minutes, hours, etc.), and

(4) Repetition rates in performing tasks (number of times per minute, hour, day, week, etc.).

This information will subsequently be used when selecting appropriate tests for predicting task performance because it will point to the tests which measure the relevant capacity not only in terms of body segment involved, but also with consideration to task properties which can influence test selection.

Input/Output Data Summary

Input data required are:

1. Results of task analysis and quantification from phase I (I.5, I.6)

Output data for this step are:

1. Summary table of human physical capacities relevant to task performance, and

2. Frequency distributions of relevant physical capacities for successful task performance.

II.2 Test Documentation and Inventory

The study design contractor has searched the literature for potential tests which proport to validly measure various physical capacities (Appendix 4).

Within the description of each of the tests is given the capacity measured, the appropriate body segment and type of action measured, the equipment needed to administer the test, the procedures for administration and scoring the tests, and a reference. When there are several variations of a test, a representative test is described and the sources for the variations are indicated. Comments on special problems, procedures, etc. are also included as appropriate.

It must be noted that these tests were often originally designed to measure general "fitness" of the capacity involved for comparison to other individuals rather than to actual task demands. Therefore, the scoring is usually based on a time or repetition number instead of physical units of work or power. However by knowing the weight of the individual or apparatus involved, the distance, and the time or repetitions, it is possible to translate these into units of power, work, etc. as appropriate (i.e., the number of chin-ups can be converted to a value of foot-pounds).

Once the physical units of the tasks are known, the tests will be screened to retain those which can be scored in terms of the required units of measure. Appropriate scoring procedures will then be developed for these tests to make maximal use of tabular formats as opposed to requiring separate individual calculations.

While an attempt has been made to provide as complete a list of standardized tests as possible, the development contractor should be allowed to consider, for inclusion as a potential test, any appropriate test which appears in the literature subsequent to the design study or which was inadvertently omitted from Appendix 4, subject to the approval of the contract monitor.

Input/Output Data Summary

Input data required are:

1. Tests listed in Appendix 4,

2. Standardized tests measuring relevant physical capacities that have appeared in literature subsequent to Design Study, and

3. Physical units of the task analysis to be matched by aptitude tests.

Output data for this step are:

1. Up-to-date list of tests measuring relevant physical capacities, and

2. Revised scoring procedures for tests in terms of appropriate physical units used in task quantification.

II.3 Identify Candidate Tests for Inclusion Within Test Battery

In order for a test to be considered appropriate for inclusion within the Test Battery it must be able to measure a relevant physical capacity identified in the task analysis and be hazard approved in accordance with the provisions within DI-H-3278.

Based on a mini-questionnaire (Appendix 1), which indicated that most difficult and demanding tasks involve manual materials handling, a list of likely candidate tests (Table 6) have been compiled from the inventory of tests in Appendix 4. Task demands may include requirements for strength/stamina, but since there is little correlation between these two characteristics, tests for both strength/stamina have been included. Static and dynamic tests are also included to evaluate static and dynamic task requirements for the different body segments.

The results of the computer analysis conducted in II.1 on the data concerning relevant physical capacities will be used to verify the selection of the likely tests listed in Table 6. If there are additional tests needed but not represented in this list they will be selected from the inventory of tests provided in Appendix 4.

The final selection of tests for inclusion in the list of candidate tests will take the following factors into consideration:

(1) Similarity in physical capacities measured,

(2) Administration time,

(3) Ease of administration,

(4) Scoring time,

(5) Training required for test administrators,

(6) Overall test safety,

(7) Equipment considerations, i.e., cost, availability, calibration, maintenance, accuracy, and reliability,

(8) The level of test accuracy and reliability indicated by the literature, and

(9) Minimum disruption of AFEES and BMT procedures as determined by an analyses of their schedules.

The contractor will evaluate the requirements of each test with regard to administration time, recovery time, and test space. In developing equivalent sequences in which the tests are to be administered, various factors will be considered. Some of these factors are:

(1) Time needed to allow for adequate recovery between tests,

(2) The space available for administering the tests, and

(3) The availability of incumbents or enlistees based on an analysis of AFEES and BMT schedules.

TABLE 6

PROPOSED TESTS FOR INCLUSION IN INITIAL TEST BATTERY

COMPONENT TESTED	TEST*	REFERENCE	EQUIPMENT NEEDED
I. Arm/Shoulder Strength A. Dynamic	Chin-up/Pull-up (II)	Basic Physical Performance Test- Larson, 1974 Indiana Motor Fitness Test- Mathews, 1973 Physical Fitness Index- Mathews, 1973 USDA Forest Firefighters Battery - Sharkey and Jakkula, 1977 Fleishman, 1964.	horizontal bar (2-5cm diameter) and/or still rings, chalk for hands, stopwatch (for timed tests only), floor mat (optional-safety item).
	Flexed or Bent Arm Hang (II)	Basic Physical Performance Test - Larson, 1974 Fleishman, 1964.	horizontal bar (2-5cm), hand chalk, stopwatch, step stool
	Push Ups (II)	Physical Fitness Index- Mathews, 1973 Indiana Motor Fitness Test- Mathews, 1973 USDA Forest Firefighters battery - Sharkey and Jakkula, 1977 Fleishman, 1964.	stopwatch (for timed tests only), 13" stall bar bench (for modified version only)
	Push Weights (II)	Fleishman, 1964.	padded bench (6'long X 1' wide X 1½' high), barbell (37 lbs. total), stopwatch.

TABLE 6

PROPOSED TESTS FOR SELECTION OF INITIAL TEST BATTERY CONTINUED

COMPONENT TESTED	TEST*	REFERENCE	EQUIPMENT NEEDED
B. Static	Hand Grip Strength (II)	Physical Fitness Test- Mathews, 1973 Basic Physical Performance Test - Larson, 1974 Basic Fitness Battery- Fleishman, 1964.	hand grip dynamometer
II. Leg/Hip Strength			
A. Dynamic	Deep Knee Bends (II)	Fleishman, 1964.	stopwatch
	Push Weights Feet (II)	Fleishman, 1964.	quadricep boots with weights, floor mats (4" thick), stopwatch
B. Static	Leg Extension- Standing (II)	Physical Fitness Index- Mathews, 1973	dynamometer with platform, handle, and chain; stabilizing strap.
III. Trunk Strength			
A. Dynamic	Sit-Ups (II)	Basic Physical Performance Test - Larson, 1974 USDA Forest Firefighter Battery - Sharkey and Jakkula, 1977 Fleishman, 1964.	floor mat, stopwatch

TABLE 6

PROPOSED TESTS FOR SELECTION OF INITIAL TEST BATTERY CONTINUED

COMPONENT TESTED	TEST*	REFERENCE	EQUIPMENT NEEDED
	Leg Lifts (II)	Basic Fitness Test Battery- Fleishman, 1964.	floor mat, stopwatch
B. Static	Trunk Extension (II)	Kamon and Goldfuss, 1977 Clarke, 1966.	test table or upright test device, anchoring strap, dynamometer or load cell
	Trunk Flexion (II)	Clarke, 1966	test table, anchoring strap, dynamometer
	Leg Raiser (II)	Fleishman, 1964.	floor mat, stopwatch
	Hold Half-Sit-Up (II)	Fleishman, 1964.	floor mat, stopwatch
IV. Cardiovascular Fitness	Ohio State Univ. Step Test (IV)	Mathews, 1973.	stopwatch, stepping bench with handbar, metronome, pulse meter (may be done by hand by experienced individual).
	Percentage Body Fat (I)	Field Battery Test- Bernauer & Bonanno, 1975 Doolittle, 1975.	skinfold calipers

*Hazard category according to MIL-STD 882 given in parenthesis following the test name.

Lack of consideration of these factors would adversely affect the reliability of the measurements taken. All of these factors will be addressed in a test manual prepared by the contractor for use when administering the tests for training purposes. Based on experience obtained during test validation the test manual will be modified as necessary so it can be used for training of Air Force personnel prior to administering subsequent tests.

Input/Output Data Summary

Input data required are:

1. Up-to-date list of tests that will measure the relevant physical capacities of individuals, and

2. Results of computer analysis conducted in step II.1.

Output data from this step are:

1. Candidate tests for inclusion within the test batteries.

II.4 Administering of Likely Candidate Tests to Sample of Individuals

After the quantification of task demands, selection of PCTs, and simulation of task demands using simple tasks, the candidate tests will be administered to a sample of enlistees at BMT.

As mentioned in I.6, if it is possible to simulate the representative tasks (PCTs) of the AFSC with simple tasks which are elements of the PCTs then the use of enlistees will be possible. Such an approach (alternative 1 in I.6) will make it more cost effective as well as more feasible because of the larger range of physical demands of the enlistees as compared to incumbents in the field. This will enable the contractor to have a group of individuals who will be successful in performing these simulated tasks and another group who will be unsuccessful in performing these simulated tasks. Therefore, the cutoff score for each of the job categories can be better defined.

If alternative 1 is not feasible because of the difficulty in simulating the PCTs, then alternative 2 will be used and incumbents instead of enlistees will be tested using the candidate tests defined in II.3. The same procedures will be used on the test scores detailed in phase IV regardless of whether alternative 1 or 2 was used.

Input/Output Data Summary

Input data required are:

1. Candidate tests instructions and equipment, and

2. Simulated PCTs, their equipment and procedures.

Output data for this step are:

1. Scores for candidate tests administered to individuals at BMT using simulated tasks.

II.5 Armed Forces Examination and Enlistment Station (AFEES) and Basic Military Training (BMT) Schedule Analyses

Implementation of strength/stamina aptitude test batteries at the AFEES and BMT center will require careful planning. Since these schedules are now considered "tight," the inclusion of additional activities, such as the test batteries, could have an adverse effect. Therefore, a study of these schedules will be made to evaluate the possible alternatives for test battery implementation. A few of the factors to be considered in these studies are outlined in Appendix 3.

A site visit to either or both the BMT center and an AFEES station may be required.

Input/Output Data Summary

Input data required are:

1. AFEES and BMT schedules.

Output data from this step are:

1. Analyses of the AFEES and BMT schedules.

Phase III. Defining Equipment for Strength/Stamina Aptitude Tests and Task Measurement

The objective of phase III is to define the equipment which will be used to:

(1) Measure the task demands of the AFSCs in phase I,

(2) Perform the objective strength/stamina tests identified as candidate tests for the test battery of phase II, and

(3) Validate the assignment criterion of phase IV.

To accomplish these objectives, close coordination with the other phases will be maintained. This will be especially true with regard to phase I and phase II since both of these phases will have varied equipment requirements. Since the selection of equipment for phase IV (to be used to validate the "assignment criterion") will be based on the test equipment used in phase II, the probability of any change is unlikely.

III.A Equipment for the Measurement of Task Demands (Phase I)

III.A.1 Define Needed Equipment

A preliminary list of equipment which may be needed for conducting the task quantification has been compiled (Table 7).

TABLE 7

TASK MEASUREMENT EQUIPMENT

dynamometer, push/pull

load cells

torque gauges

Using this list as a base, any additional equipment and/or supplies that may be needed will be added as required. A set of equipment will be finalized for measuring task demands. The basis for determining this set will rest on those attributes of the tasks requiring physical measurements.

III.A.2 Perform Preliminary Hazard Analyses

Once the relevant equipment, accessories, and associated supplies have been identified, they will undergo a preliminary hazard analysis in accordance with DI-H-3278, Section 10, paragraph 3. Only that equipment which complies with the above criteria will be used for quantifying the attributes of the PCTs' measurements.

III.A.3 Procurement of Equipment

The equipment, accessories, and supplies needed will be placed on order, with the appropriate lead time, after the equipment requirements have been finalized. Packaging and handling requirements, as appropriate, will be included in the purchase request to ensure that time is not lost as a result of damage to the equipment during shipment (Level C of MIL-STD-794).

The contractor will conduct an operational checkout and calibrate the equipment according to the manufacturer's specifications prior to its use in phase I (I.5).

Input/Output Data Summary

Input data required are:

1. List of equipment needed for conducting the task analyses and quantifications,

2. Preliminary hazard analysis procedures - DI-H-3278, Section 10, paragraph 3, and

3. Procurement procedures and forms.

Output data for this step are:

1. Identification and procurement of equipment for the measurement of task demands.

III.B Equipment for the Measurement of Physical Capacities (Phase II)

III.B.1 Define Needed Equipment

A listing of equipment needed has been indicated in the test descriptions listed in Appendix 4. It is anticipated that the equipment, etc. needed for the candidates tests identified in phase II will be a subset of the equipment listed in Appendix 4. However, should it be necessary to select a specific variation of the test(s) described in Appendix 4 an appropriate analysis will be conducted to ensure that the equipment needed is properly redefined.

III.B.2 Perform Preliminary Hazard Analyses

The relevant equipment, accessories, and associated supplies will undergo a preliminary hazard analysis in accordance with DI-H-3278, Section 10, paragraph 3. Only that equipment which complies with the above criteria will be used for physical capacity measurements. Compliance with the above requirements is essential to ensure the safety of Air Force personnel who are in any way involved in the utilization of this equipment.

III.B.3 Procurement of Equipment

The equipment accessories and supplies needed for the measurement of physical capacities will be placed on order, with the appropriate lead times, after the equipment requirements have been finalized. Packaging and packing requirements, as appropriate, will be included in the purchase to afford adequate protection against physical damage during shipment for all deliverable items (Level C of MIL-STD-794).

The contractor will conduct an operational checkout and calibrate the equipment according to the manufacturer's specification prior to its use in phase II (II.6).

Input/Output Data Summary

Input data required are:

1. List of equipment needed for the tests listed in Appendix 4,

2. List of tests to be used for the measurement of physical capacities,

3. Preliminary hazard analysis procedures - DI-H-3278, Section 10, paragraph 3, and

4. Procurement procedures and form 5.

Output data for this step are:

1. Identification and procurement of equipment for the measurement of physical capacities.

III.C Equipment for the Longitudinal Validation (Phase IV)

III.C.1 Define Needed Equipment

It is anticipated that the test batteries, finalized and used in phase IV, will be subsets of the Initial Test Battery. The selection criterion to be used in determining the needed equipment is addressed in phase IV.

III.C.2 Perform Preliminary Hazard Analysis

The relevant equipment to be used in phase IV will have undergone a preliminary hazard analysis prior to its selection for use in phase II to measure incumbents.

III.C.3 Procurement of Equipment

The equipment requirements for the tests selected will be reviewed to determine if the same equipment utilized in phase II is suitable for use in mass screening procedures. Consideration will also be given of any new models that may facilitate the testing procedures (but are still measuring the same physical capacities).

Any additional equipment, accessories, and supplies needed for the measurement of physical capacities will be placed on order, with the appropriate lead times, after the equipment requirements have been finalized and the analysis of the BMT schedule has been completed. Packaging and packing requirements, as appropriate, will be included in the purchase request to afford adequate protection against physical damage during shipment (Level C of MIL-STD-794). After the Primary Test Battery has been finalized (addressed in phase IV) and the analysis of the AFEES schedule has been completed, the equipment, accessories, and supplies needed within the AFEES will be itemized.

The contractor will conduct an operational checkout and calibrate the equipment according to the manufacturer's specifications prior to its use in the longitudinal validation.

Input/Output Data Summary

Input data required are:

1. List of equipment as needed for the primary and secondary test batteries,

2. Preliminary hazard analysis procedures - DI-H-3278, Section 10, paragraph 3, and

3. Procurement procedures and forms.

Output data for this step are:

1. Identification and procurement of equipment for the longitudinal validation.

Phase IV. Finalization and Validation of the Assignment Criterion

Phase IV is concerned with the selection and finalization of the primary and secondary test batteries based on the data collected on a sample of enlistees of BMT (phase II).

A longitudinal study will be conducted to establish the validity of the criterion developed for assigning individuals to AFSCs having heavy physical demands. Any effects due to BMT on the individual capacities will be identified and incorporated in the assignment criterion during this phase.

IV.1 Selecting the Secondary Test Battery and Developing the Final Assignment Criterion for Success on AFSCs[1]

The size and strata of the sample population to be physically measured within phase II in order to quantify relevant physical capacities as these capacities relate to an individual's performance on the job (measured by successful and unsuccessful performance on the simulated PCTs) will depend upon the data requirements needed to develop the physical capacity measures for use within the final assignment criterion. The data requirements needed will depend on the final statistical procedure selected for this purpose.

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[1]Sample sizes and their composition may be changed as a result of any constraints, task requirements, analysis, and availability of personnel for inclusion in these samples.

Before a final statistical procedure is selected, several preliminary data analyses will be performed to explore relationships that may exist between the variables of the physical demands of the PCTs and the variables of the physical capacities of the incumbents as related to performance within the AFSCs. These data analysis techniques include regression and correlation analysis. Furthermore, factor analysis will be used to identify the structure within the sets of these variables.

The regression and correlation analyses will be used to determine the job's demand levels for which the enlistees are best suited (or not suited). This will enable the contractor to determine which variables are to be used in relating job demands to worker capability and thus give a preliminary identification of those tests that may be used as the "secondary test battery." The finalization of this secondary test battery will, in part, be based on the results of the final statistical procedure selected.

The statistical procedure selected for finalizing the secondary test battery is a stepwise discriminant analysis. The following is a brief summary of how the approach is to be used and the rationale for making this selection.

The main purpose of discriminant analysis is to provide a mathematical model which can be used to classify a person into one of several categories based on the secondary test battery of the candidate tests identified in phase II. The "Stepwise Discriminant Analysis" in the SPSS computerized statistical library will be used to implement the method.

The input data used to develop the model consists of the candidate test scores for a sample of persons at BMT in which each person is uniquely identified[1] as belonging to one of a set of $k \leq 3$ categories. Categories here refer to the level of heavy work. If three levels are selected, then three categories will be identified which have different levels of heavy demands. The output consists of a set of (k-1) linear discriminant functions which are useful for indicating the important variables for each category (k=1,2,3). In addition, a set of k linear classification functions are computed which are used to classify a person into a category based on the secondary test battery scores which have been identified in a one-variable-at-a-time manner. The classification functions give the posterior probability that the person being classified belongs in each category. These are then computed for each category and the person is classified as belonging to that category for which the posterior probability is largest.

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[1]These individuals will have been identified as successful performers, and unsuccessful performers based on their performance of the simulated PCTs.

Each person in the sample is classified according to this procedure and approximate misclassification error rates are then computed.

There are two major reasons for selecting this approach:

(1) The simulated PCTs for the AFSCs represent a set of "categories" of tasks. The categories are actually the different levels (3) of physical demands. A cluster analysis on the results of the task classification questionnaire will have been performed. This analysis will reveal the frequency distribution of the tasks within selected AFSCs based on the physical demands of these tasks. Stepwise discriminant analysis provides a natural means for classifying people into these categories based on the secondary test battery measurements.

(2) The discriminant analysis approach should provide the answer to the question: can the strength/stamina measurements in the candidate tests be used to accurately classify an individual into one of the categories? An affirmative answer to this question is based on the results of a small scale discriminant analysis conducted at Texas Tech University.

A discriminant analysis was performed on a set of 47 industrial subjects (27 males and 20 females) for which 28 strength/fitness/anthropometrical/endurance measurements (the pilot study's full test battery) were made on each subject.[1] The criterion variable of interest was the acceptable weight of lift.[2]

The application of the stepwise procedure yielded nine variables (a subset test battery) to be used in performing the classification. Based on the analysis using these variables, only one subject out of the 47 was misclassified. This is an observed overall misclassification error rate of only 2.1 percent. Because many of the current AFSC simulated PCTs involve manual materials handling, similar misclassification error rates are projected in the proposed study.

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[1]Predictive Models for the Maximum Acceptable Weight of Lift, by Ronald Eugene Knipfer, unpublished Ph.D. dissertation, Texas Tech University, August, 1974.

[2]The maximum weight that a subject would voluntarily lift at a rate of 5 lifts per minute for 40 minutes, Knipfer (1974).

Preliminary results on the use of a discriminant analysis model for classifying persons in regard to their ability to lift have yielded several important results. One such result is that misclassification errors regarding median lifting capability of less than 5 percent can be achieved with fewer than 10 strength/stamina measurements and a sample size of 45 persons. It is assumed that this will also be true in this study. Consequently, a sample size of 50 persons in each category should be sufficiently large and will yield approximately 40 degrees of freedom for accurately measuring the random error variation within each category. In order to make accurate comparisons between male and female capabilities, it is recommended that, within each category, 50 males and 50 females be measured. The actual number of the categories to be used will depend upon the results of the cluster analysis performed on the task classification. For purposes of illustration, the following three category model (Table 8) is used.

TABLE 8

A CATEGORY MODEL OF SIZE AND STRATA OF SAMPLE POPULATION

Category	Description	Required Sample Size	
		Males	Females
I	A person can satisfactorily perform heavy jobs of level 3	50	50
II	A person can satisfactorily perform heavy jobs of level 2	50	50
III	A person can satisfactorily perform heavy jobs of level 1	50	50
	TOTAL	150	150

It is noted that the total sample of 150 males and 150 females is also adequate for use in fitting the multivariate linear regression model discussed in the previous section. In that case, if 10 secondary test battery strength/stamina measurements are to be used to predict as many as 10 task descriptor variables, there will be a total of 289 degrees of freedom available for estimating the error covariance matrix (Table 9). From past experience with similar prediction models, this will be adequate. It should be noted that the test batteries will be reduced in terms of the number of tests with minimum sacrifice in prediction capability.

TABLE 9

RESIDUAL DEGREES OF FREEDOM IN A
10 VARIABLE BY X CATEGORY MODEL

Number of Variables	Number of Categories	Residual Degrees of Freedom
10	2	189
10	3	288
10	4	387
10	5	486

The input data to this analysis concerning the physical demands of the AFSCs will be obtained in phase I. The data concerning the physical capacities of a sample of enlistees and the evaluation of the performance of these enlistees on the simulated PCTs will have been obtained in phase II.

The main advantage of sampling the enlistee population is that it will permit easy access to an adequate number of readily available individuals. It is important for all the important AFSC task demand variables, such as strength and stamina, to be adequately represented in the sample. To ensure this, a cluster analysis will have been performed on the results of the questionnaire survey. The sample will then be stratified into the cases (subjects) by variables clusters obtained in the cluster analysis. This will ensure a comprehensive representation of the unique AFSC task requirements characteristic to certain categories of tasks.

An alternate statistical procedure to the stepwise discriminant analysis is the multivariate regression analysis. Within this procedure the test battery variables are used as predictor variables for explaining the vector of task description variables expressed in physical units. Appropriate percentiles and regions of the predicted description vector can then be identified for use in assigning persons to jobs having heavy physical demands.

Input/Output Data Summary

Input data required are:

1. Physical demand data for PCTs, physical capacity data for a sample of enlistees, performance data for incumbents, and

2. AFEES-BMT schedule analyses results.

Output data for this step are:

1. Secondary test battery for use at BMT, and

2. Final assignment criterion for success on AFSCs.

IV.2 Selecting the Primary Test Battery and Developing the Initial Assignment Criterion

The primary test battery will be identified and selected after the selection of the secondary test battery. The primary test battery could be:

(1) The same as secondary test battery,

(2) A subset of the secondary test battery,

(3) A set of tests entirely different from the secondary test battery, or

(4) A combination of 2 and 3.

The recommended procedure is to utilize the same tests for the primary and secondary test batteries, thereby, minimizing the sources of "assessment" variation to such items as test administration and delayed enlistment. However, recognizing the differing constraints (time, control, etc.) the primary test battery selection will consider the following:

(1) The test selected for the primary battery should be the least stressful;

(2) These tests should also be the least time consuming due to the crowded schedules of AFEES;

(3) These tests should show reasonably high correlations with task success on heavy tasks; and

(4) These tests should be easy to administer and require the least training for personnel and least amount of instruction to the subjects.

After the selection of the primary battery an "initial assignment criterion" will be developed using the primary battery. This will be necessary only if the two batteries are not identical. The development of the initial assignment criterion will follow the same procedures outlined for the development of the "final assignment criterion" (Based on the secondary battery).

Both the final and initial assignment criteria will be validated using the procedures described under the longitudinal validation section. If needed, assignment criteria may be modified for either battery during this phase to ensure that the predictions of these batteries are within the specified tolerance.

Input/Output Data Summary

Input data required are:

1. The secondary test battery contents,

2. List of potential tests for the measurement of physical capacities, and

3. AFEES-BMT schedule analyses results.

Output data for this step are:

1. The primary test battery for use at AFEES, and

2. The initial assignment criterion.

IV.3 Location of Test Station During Validation Period

The contractor shall submit for Air Force approval the number and location of the test stations for the validation of the primary and secondary test batteries. The initial sites for these test stations will be within the facilities of BMT. Because no experimental activities can be planned at AFEES, it is proposed that the site, at BMT, for administering the primary test battery be separated from the site for administering the secondary test battery.

The number and location of the test stations at each site will be a function of

(1) The total number of individuals needed for the validation procedures,

(2) The time allotted to complete the particular validation, and

(3) Costs involved.

By the time the primary and secondary test batteries and the assignment criteria have been declaired operational by the Air Force and are ready to be incorporated within the schedules of the AFEES, the number of test stations required per AFEES will have been determined based on analyses of the requirements at each AFEES.

Input/Output Data Summary

Input data required are:

1. Total number of individuals needed for the validation procedures,

2. Time allotted to complete the particular testing and validations, and

3. Costs and space availability.

Output data from this step is:

1. Location of test station for validation period.

IV.4 Conduct Field Studies to Investigate the Effect of Basic Military Training (BMT)

Each first-term enlistee receives basic military training. After receiving such training, some of the enlistees may show an improvement while some may show a decrement in their physical capacities as measured by the primary or secondary test batteries. Similarly, some of the enlistees may show no change.

In order to investigate these effects, a field study will be conducted. A sample of enlistees selected at the beginning of BMT will be administered the secondary test battery and their scores tabulated. The same group will be retested and their sources tabulated at the end of BMT.

Two types of tests will be performed on this data: The first test will investigate whether or not, as a result of BMT, there is a significant difference in the distribution of each capacity as reflected by the administration of the secondary test battery both before and after BMT.

To illustrate this, let:

μ_0 and σ_0^2 be the mean and variance of the population of a specific capacity of interest before BMT, and μ_1 and σ_1^2 be the mean and variance of the distribution of the same capacity after BMT.

Then using standard (t) testing procedure the Hypothesis $H_0: \mu_0 = \mu_1$ against $H_1: \mu_0 \neq \mu_1$, can be tested. If H_0 is accepted, then it can be claimed that generally BMT does not have an effect.

The second test will investigate the change in scale. The hypothesis $H_0: \sigma_x^2 = \sigma_y^2$ will be tested using the F-test which assumes the distributions of x and y are normal. (Normality can be tested.) If the distributions are not normal, then a nonparametric test will be used. The selection of the appropriate test, depending on whether the distributions are symmetric or nonsymmetric, will

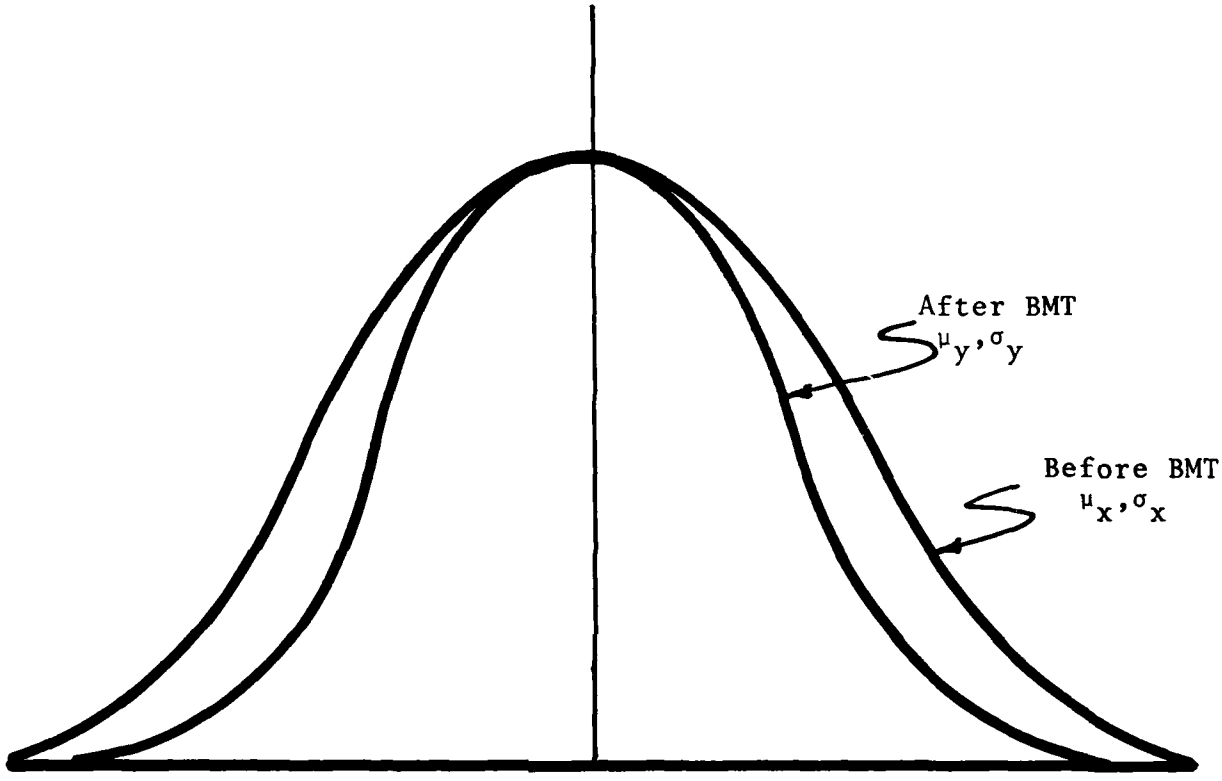


Figure 8. Possible Distributions of Some Physical Capacities Before and After BMT.

be made once the distributions of these capacities are available.

The second test is of value because it can establish whether or not individuals in specific capacity categories increase, remain unchanged, and/or decrease in all or some of their capacities as a result of BMT. It is anticipated that as a result of BMT, individuals with certain low capacities before BMT will increase in some of these capacities and, individuals with certain high capacities will remain the same or decrease in some of these capacities. This is illustrated in Figure 8 where the outcome would be a reduction in the spread of the distribution after BMT, i.e., a change in scale.

If there are two values (x,y) for each of n individuals, then one can use the model $y = \alpha + \beta x + \epsilon$ to predict y from x. The parameters α and β can be estimated using standard regression methods. A 95 percent confidence interval for the "true" predicted value y corresponding to a value of x (pre-training value) is given by

$$\hat{y} \pm s_{\hat{y}}\, t_{n-2,.975}$$

where y is the value predicted from the model, $t_{n-2,.975}$ is the 97.5 percentile value from a t-distribution with n-2 d.f., and

$$s^2_{\hat{y}} = \left(1 + \frac{1}{n} + \frac{(x-\bar{x})^2}{(x_i-\bar{x})^2}\right)\hat{\sigma}^2 .$$

An estimate of variation about the regression line is

$$\hat{\sigma}^2 = \frac{\sum(y_i - \hat{\alpha}-\hat{\beta}x_i)^2}{n-2} .$$

The width of the confidence interval is smallest when the pre-training value $x = \bar{x}$. As the value of x recedes from $\bar{x}$ the width gets large.

The size of the sample n required depends on the width of the confidence interval of y desired. The width of the confidence interval is

$$\text{Interval Width} = \hat{y} + s_{\hat{y}}\, t_{n-2,.975} - (\hat{y} - s_{\hat{y}}\, t_{n-2,.975})$$

$$= 2s_{\hat{y}}\, t_{n-2,.975} .$$

If $s_{\hat{y}}$ is taken to be $\sigma_{\hat{y}}$ (approximately), then the interval width is given by:

$$\text{Width} \simeq 2S_{\hat{y}} = 2\left(1 + \frac{1}{n} + \frac{(x-\bar{x})^2}{\sum(x_i-\bar{x})^2}\,\frac{1}{2}\,\hat{\sigma}^2\right)$$

from which n can be calculated at the 95 percent confidence level given an interval width. The interval width will be taken to be 5 percent of the mean.

These tests will assure that any changes in BMT are detected and accounted for in the assignment criteria.

Input/Output Data Summary

Input data required are:

1. Results from the administration of the secondary test battery to a sample of enlistees prior to the initiation of their basic military training, and

2. Results from the administration of the secondary test battery to a sample of enlistees upon completion of their basic military training.

Output data from this step are:

1. Data regarding the effects of basic military training on an individual's secondary test battery results.

IV.5 Longitudinal Validation of the Assignment Criteria

The following addresses the validation of the selection and assignment criteria for both the primary and secondary test batteries.

The validity of the final assignment criterion will be measured by its ability to accurately predict an individual's physical ability to perform the simulated PCTs. The appropriate prediction will be based on the classification to which an individual is assigned based on measured physical capacities.

The final assignment criterion shall be considered valid if the misclassification error rates are 5 percent or less with a 95 percent statistical confidence. Thus, there shall be two types of error that may be encountered. A type I error is an error which occurs whenever a person is classified as belonging to category I (see Table 8) according to the current X-factor

procedure, who in fact rightly belongs in category II or III. Similarly, type II error occurs whenever a person is classified into category III according to the current X-factor procedure, who rightly belongs in category I or II. If more than three categories are used similar type errors can be defined.

First consider the validation of a type I error rate of 5 percent with 95 percent statistical confidence. Additionally, it would be desirable to establish a protection probability of at least 90 percent against the possibility of concluding that the type I error rate is no larger than 5 percent when in fact it is as large as 10 percent. By means of simple statistical considerations based on the binomial distribution, a validation sample of size 225 containing a maximum of 16 misclassifications would be necessary. This procedure would be implemented as follows: a random sample of persons will be administered the secondary test battery (the second day of BMT) in order to identify 225 individuals classified as and assigned to each category of AFSCs under current procedures, who are classified under the proposed criterion as being in a lower demand category. If the Air Force deems it necessary to test the assignment criterion to other than the three heavy categories it will be necessary to obtain a similar sample size for each category. Once assigned to an AFSC, these persons will be observed for a six month period in order to assess their job performance. If 209 or more of these persons in each category are evaluated as being physically unable to perform the simulated PCTs based on the evaluation procedures discussed in phase I, a type I error rate of 5 percent, maximum, will have been validated at the 95 percent confidence level.

In order to validate a maximum type II error rate of 5 percent with 95 percent confidence, a sample of size 225 people will be used for each category. However, there is one important problem that must be overcome. Because this error concerns a population who rightly belongs in a category to which they most likely will not be assigned based on the current procedures, a problem arises. To overcome the problem, it is proposed that 225 persons be allowed assignment to the category based on the new assignment criterion. These persons will likewise be monitored for a minimum six month period. If 16 or fewer of these persons in each category are evaluated as being physically unable to perform the simulated PCTs within an AFSC based on the evaluation procedures discussed in phase I, then a type II error rate of 5 percent, maximum, will have been validated at the 95 percent confidence level.

A validation study will be made concerning the "initial assignment criterion" against the "final assignment criterion." A similar procedure used to validate the final assignment criterion will be used here to validate the initial assignment criterion. Again, a tolerance of 5 percent will be observed here, i.e., a 5 percent for either type I or type II error will be used.

Input/Output Data Summary

Input data required are:

1. Initial assignment criterion information for each individual in the validation sample,

2. Final assignment criterion information for each individual in the validation sample, and

3. X-factor ratings for each individual in the validation sample.

Output data for this step are:

1. Validation of the reliability of the initial assignment criterion and the final assignment criterion as predictors of an individual's performance capability within a particular AFSC, and

2. An assessment of the prediction ability of the initial and final assignment criterion versus the existing X-factor rating regarding an individual's physical performance capability within a particular AFSC.

IV.6 Document Primary and Secondary Batteries

After the completion of the longitudinal validation step and after it has been determined that the assignment criteria meet the error tolerance acceptable by the Air Force (5 percent for either type I or II errors), the task batteries will be documented under a separate cover which will present in detail the following sections for each test included:

(1) The tests performed,

(2) The exact procedure used, posture assumed during the test, ... etc.,

(3) Equipment utilized, how used, how checked, and calibrated, ... etc.,

(4) Instructions to the subjects,

(5) Instructions to technicians administering the test,

(6) Methods of scoring and tabulation, and

(7) Expected norms for each test.

Input/Output Data Summary

Input data required are:

1. Test battery information (primary and secondary) such as, tests performed and procedures used, equipment utilized and procedures, subject instructions, technician instructions, methods of scoring and tabulation, and expected norms for each test.

Output data for this step are:

1. Documentations in the form of a manual for the use of the primary and secondary batteries, and the initial and final assignment criterion.

III. PROJECT SCHEDULE

The proposed project schedule is shown on the following diagram and encompasses a 48 month performance time utilizing 136 person-months of effort. In addition, a three month period following the 48 month performance time has been scheduled for preparation of a final report. Progress reports will be submitted at six month intervals.

The time allocations for each phase are as follows:

Phase I - 18.5 months
Phase II - 12 months
Phase III - 8 months
Phase IV - 18 months
Final Report - 3 months

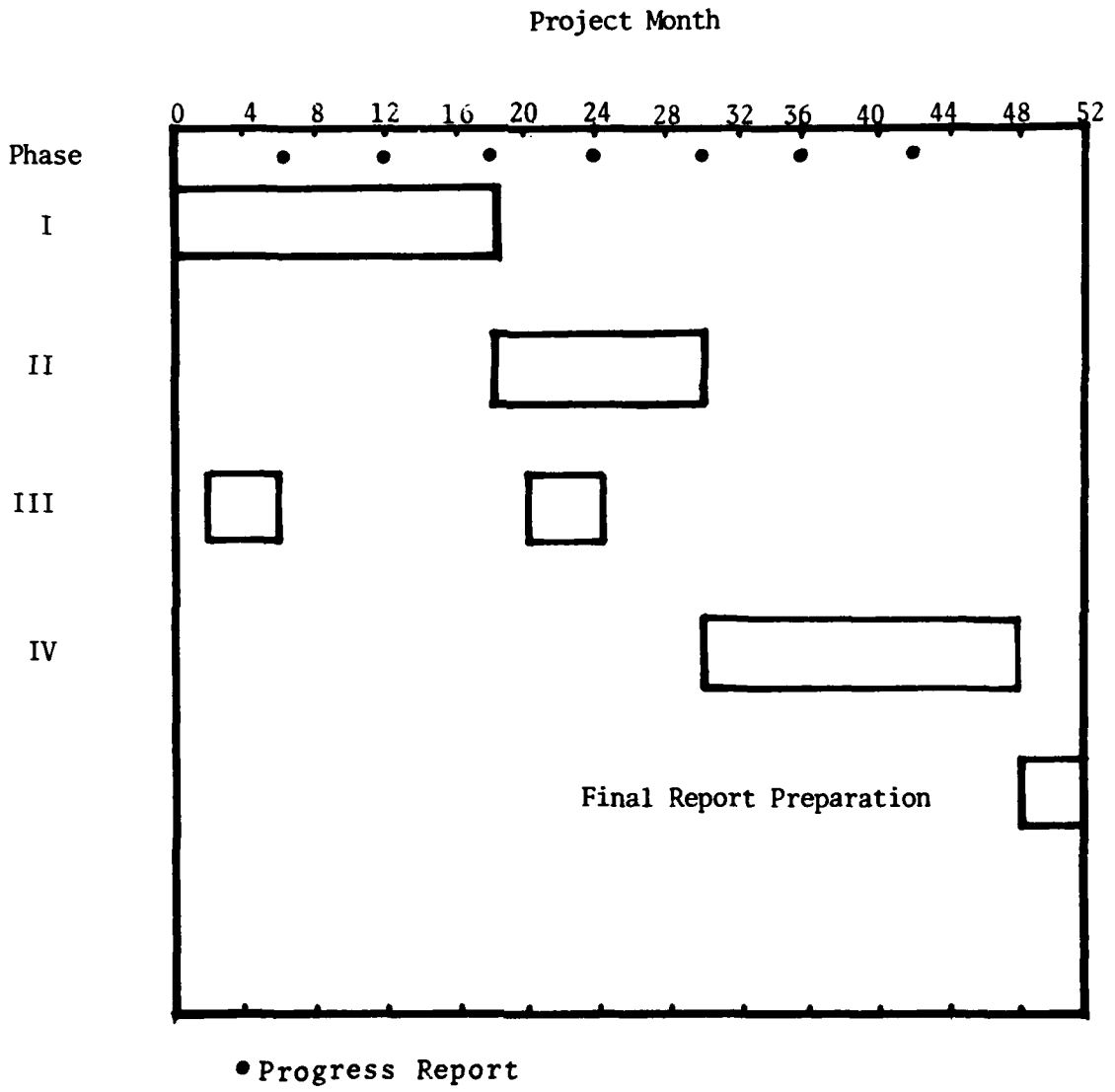


Figure 9. Project Schedule

[Note: pp 71 & 72 were deleted.]

APPENDIX 1

AIR FORCE SPECIALTY CODE (AFSC) MINI QUESTIONNAIRE

Different "physical task performance" questionnaires, i.e., each applicable to a specific AFSC (see example at the end of this Appendix), were administered to a combined total of 76 incumbents at Dyess AFB, Texas and Reese AFB, Texas covering 11 AFSCs that are currently rated as X-factor 1 (see Table 1). The purposes of the survey were to:

(1) determine the general nature of the physical tasks that may be encountered in AFSCs requiring "heavy" and/or "very heavy work" (e.g., manual materials handling, torquing, running, standing, and so forth),

(2) determine the degree of task procedure standardization,

(3) determine the relative task requirements as a function of mission, and

(4) obtain, based on items (1), (2), and (3) above, data that would enable a better selection of an appropriate strength/stamina "initial test battery" to be used in predicting the ability of an individual to "successfully" perform the AFSCs which have "heavy" and/or "very heavy" physical demands.

The survey results (see Table 2 for summary) indicate that the incumbents perceive a total of 286 tasks as being "physically demanding." The survey results showed that these 286 tasks can be categorized as follows:

(1) 258 manual materials handling (MMH) type activities or 90 percent,

(2) 7 torquing activities of some type or 3 percent, and

(3) 21 miscellaneous activities, such as sentry duty, guard duty, dog catching, and first aid involving resuscitation or 7 percent.

Based on undocumented observations, undocumented verbal communications with the incumbents, and questionnaire narrative responses, it was determined that task procedure standardization is not necessarily Air Force, Command, or Base-wide, and that task requirements are, for some AFSCs, a function of the unit's mission, e.g., SAC, MAC, or ATC oriented. It was also confirmed that supervisors are experiencing difficulties in manpower planning due to physical deficiencies of the incumbents. However, this may be the result, in part, of a "prejudgement" by the supervisors regarding the abilities of an individual to perform a "heavy/very heavy" task. A few of

Table 1

AFSC'S AND INCUMBENT'S SURVEYED

AFSC	Dyess (Sac-Mac base) Number of Incumbents	Reese (ATC base) Number of Incumbents
113X0 - Flight Engineer	(2)	NA*
114X0 - Aircraft Loadmaster	(3)	NA
362X4 - Telephone Equipment	(1)	NA
551X0 - Pavements Maintenance	(3)	(2)
551X1 - Construction Equipment	(2)	(2)
552X0 - Carpentry	(2)	(2)
571X0 - Fire Protection	(5)	(6)
631X0 - Fuel	(5)	(4)
811X0 - Security	(14)	(9)
811X2 - Law Enforcement	(4)	NA
922X0 - Aircrew Life Support	(6)	(4)
	47	29

NA* not available at this base

TABLE 2

AFSC QUESTIONAIRE RESULTS SUMMARY

AFSC	TOTAL TASKS DIFFICULT	TASK CATEGORY					
		MMH		TORQUE		MISC	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
113X0	19	17	90	1	5	1	5
114X0	21	20	95			1	5
362X4	10	10	100				
551X0	33	33	100				
551X1	23	21	91	2	9		
552X0	33	32	97			1	3
571X0	38	36	95			1	3
631X0	32	31	97			1	3
811X0	23	23	100				
811X2	31	19	61			12	24
922X0	23	16	70	3	13	4	17
	286	258	90	7	3	21	7

the incumbents indicated that the supervisors did not assign them to physically demanding tasks because the supervisor did not think the incumbent was capable of performing the task even though there was no quantitative data available to substantiate this "prejudgement."

Finally, the results of the survey were helpful in the selection of candidate tests for the "initial test batteries" and the corresponding test equipment (see Appendix 4).

AFSC QUESTIONNAIRE

We are asking you to complete the following questionnaire so that we can learn more about your AFSC. In order to get the most from our survey, we ask that you carefully consider your answer for each question. The information which we obtain will be kept in complete confidence and will not be used for any purpose other than the present analysis of USAF AFSCs. Thank you for your cooperation; it is greatly appreciated.

In this survey, we will be using a term which we want to clearly define. The word DIFFICULT will be used to refer to tasks which require more than everyday, normal, physical effort and which, if, for example, were repeated several times, would leave you TIRED, OUT OF BREATH, NEEDING REST, OVER-HEATED, or WITH MUSCLES WHICH WILL BE TIRED AND/OR SORE. There are many different factors which might cause a task to be rated as difficult; for example, length of time it must be performed, temperature, or access to work space. Your answers for the following questions will help us identify those tasks which are physically difficult.

The questionnaire is divided into three different parts. In the first part we will ask some questions which will tell us something about you. This information is requested only to give us some idea about the person answering the other questions. If for any reason you would rather not answer any of these questions, you may leave them blank and continue with the remainder of the questionnaire.

The second part of the survey will be a list of tasks, derived from AF occupational surveys, which MIGHT be required of a person with your AFSC. There are three numbers following each task. If the task is one you do or have done, and if you find or have found it DIFFICULT, circle one -1- on the form. If it is one which you have performed but which is/was not difficult, circle the -2- on the form. If you have not done the task, circle the -3-. If you do, or have done, other tasks, other than those listed, as a part of your job or if others you work with do or have done other tasks as a part of their job and if these tasks could be described as difficult, list them in the blank spaces and place the number -1- or -2- after the task description (e.g., open hanger door manually -1; operate torque wrench -1; stand parade rest while on guard duty -1).

For each task you identified as difficult, we would like for you to BRIEFLY describe the aspect of the task which makes it difficult. Use your own words to describe the

physical aspects which make it difficult--for example, lift and hold an A/C tire, manually move AGE from shop to A/C, work is done overhead, etc. If you can, we would like for you to identify the number of lbs you lift, the amount of force applied when torquing, the type of position you must assume to accomplish the difficult tasks, etc. In other words, be as specific as you can.

Finally, in the last part of the questionnaire, there will be a number of incomplete sentences. We would like for you, in your own words, to complete the sentences.

PART 1

INSTRUCTIONS: Complete each of the following questions as accurately and as completely as possible. This information will be used for purposes of the present survey only.

1. NAME_____ 2. AGE_____
LAST FIRST M.I.

3. PHYSICAL DISABILITY _____ 4. CURRENT AFSC ASSIGNMENT_____

5. LENGTH OF TIME IN AIR FORCE ____ YRS. (APPROXIMATE) 7. MALE_____ FEMALE _____

6. HOW LONG IN CURRENT AFSC _____ YRS. (APPROXIMATE) 8. WEIGHT _____ 9. HEIGHT____

10. LIST ALL/ANY OTHER AFSC'S TO WHICH YOU HAVE BEEN ASSIGNED

_____

_____

_____

11. WHAT WAS YOUR JOB PRIOR TO ENTERING AIR FORCE?_____

12. LIST ANY ATHLETIC EXPERIENCE WHICH YOU HAVE HAD IN THE PAST THREE YEARS._____
_____

13. ARE YOU ON A REGULAR PROGRAM OF EXERCISE? IF SO, PLEASE DESCRIBE IT._____
_____

PART 2

INSTRUCTIONS: The following list of tasks might be required of a person with your AFSC. If the task is one which you do or have done, and if you find, or found, it DIFFICULT, circle -1-; if you did not find it difficult but do or have done it, circle -2-. If you have not done the task as a part of your job, circle -3-. In the blank lines following (below) the task list, write down a short description of other tasks which you have done and found difficult. Use the blank spaces to the right of the list of tasks to BRIEFLY DESCRIBE THE ASPECT OF THE TASK WHICH MAKES IT DIFFICULT. Do this for each of the tasks which you circled -1- or which you have added.

AFSC 631X0

1 - Difficult 2 - Not difficult 3 - Have not done

1.	Fuel or defuel aircraft with R-5 tank trucks	-1-2-3
2.	Perform operator maintenance on tank trucks	-1-2-3
3.	Fuel or defuel aircraft with R-9 tank trucks	-1-2-3
4.	Fill mobile refueling units from bulk storage	-1-2-3

AFSC 631X0

1 - Difficult 2 - Not difficult 3 - Have not done

5. Fuel or defuel aircraft with R-8 tank trucks -1-2-3

6. Fuel aircraft with modified Panero hydrant systems -1-2-3

7. Issue automotive oil from base service stations -1-2-3

8. Issue lox to oxygen carts -1-2-3

9. Fuel aircraft with Panero hydrant systems -1-2-3

10. Perform operator maintenance on bulk storage systems -1-2-3

11. Perform operator maintenance on Pritchard hydrant systems -1-2-3

12. Refill mobile water servicing units from demineralized water plants -1-2-3

AFSC 631X0

1 - Difficult 2 - Not difficult 3 - Have not done

13.	Perform operator maintenance on hydrant trucks	-1-2-3
14.	Fuel aircraft with Phillips hydrant systems	-1-2-3
15.	Perform operator maintenance on modified Panero hydrant systems	-1-2-3
16.	Fuel or defuel aircraft with R-2 condec tank trucks	-1-2-3
17.	Fill mobile oil units from oil storage facilities	-1-2-3
18.	Perform cryogenic liquid storage operator maintenance	-1-2-3
19.	Issue bulk oil to aircraft from MK-1 tank trucks	-1-2-3
20.	Perform operator maintenance on Panero hydrant systems	-1-2-3

AFSC 631X0

1 - Difficult 2 - Not difficult 3 - Have not done

21. Perform operator maintenance on fueling semitrailers -1-2-3

22. Perform operator maintenance on vacuum pumps -1-2-3

23. Connect or disconnect off-loading hoses from barges -1-2-3

24. Fuel or defuel aircraft with R-14 air transportable hydrant systems -1-2-3

25. Perform operator maintenance on R-14 air transportable hydrant systems -1-2-3

26. Set hand brake on railway tank cars -1-2-3

27. Fill mobile oil units from drums -1-2-3

28. Fuel or defuel aircraft with R-25 air transportable hydrant systems -1-2-3

AFSC 631X0

1 - Difficult 2 - Not difficult 3 - Have not done

29. Perform operator maintenance on C-136, C-123 aerial bulk fuel delivery systems -1-2-3

30. Perform operator maintenance on R-22 air transportable hydrant systems -1-2-3

31. Position mooring lines from barge or tanker to unloading points -1-2-3

32. Perform operator maintenance on R-25 air transportable hydrant systems -1-2-3

33. Perform operator maintenance on R-26 air transportable hydrant systems -1-2-3

34. Fuel or defuel aircraft with R-1 air transportable hydrant systems -1-2-3

35. Perform operator maintenance on R-1 air transportable hydrant systems -1-2-3

36. Perform operator maintenance on R-13 air transportable hydrant systems -1-2-3

AFSC 631X0

1 - Difficult 2 - Not difficult 3 - Have not done

37. Fuel or defuel aircraft with F-7 semitrailers -1-2-3_____

AFSC_____ 1 - Difficult 2 - Not difficult 3 - Have not done

Other difficult tasks you or others within this AFSC are expected to perform

PART 3

INSTRUCTIONS: Complete each of the following sentences in your own words.

1. Rank order, by number, the five most difficult tasks listed in Part 2.

   1_____ 2_____ 3_____ 4_____ 5_____

2. Can you list, in rank order, five additional tasks which you find difficult or you think is difficult for others to perform. Please state, as before, why you think it is difficult.

   1._____

   2._____

   3._____

   4._____

   5._____

3. What tasks may appear to be easy but are difficult to perform_____

4. When I think of physical work I think of _____

5. In order to meet the physical demands of my present AFSC a person must possess the following physical attributes:_____

6. The physical activities which help most with difficult tasks are_____

APPENDIX 2

TASK DEMAND CLASSIFICATION SURVEY INSTRUMENT RELIABILITY AND VALIDATION

The reliability and validation of the survey, which will be used to identify the task's levels of demand (phase I) for each of the AFSCs, will be performed. To accomplish this, the tasks will be identified and listed using procedures described in phase I. The purpose of this analysis at this point will be to demonstrate the reliability of the survey instrument. The sample of individuals who will be requested to respond to the questionnaire, may be selected from instructors, supervisors, or incumbents. These samples will be taken from various type mission bases and different locations so as to study the reliability for various bases and at different locations. If a particular base was multiple AFSCs then the sampling will be stratified further so as to study the reliability further according to AFSCs. The selection will be on the basis of their familiarity with the tasks and their ability to classify these tasks according to the operational definition of each level of physical demands. Whatever group these individuals are drawn from, it will be a group selected because they are the most appropriate to make the task classification, especially to reflect the mission orientation.

Each task classification on the survey instrument will be separately tested for reliability at the 90 percent level according to the following proposed method. The design of the proposed reliability methodology is depicted in Table 1 where k denotes the number of individuals and n the number of tasks. The same basic data layout will be used for each sampling situation within each location and within each mission base. The number of individuals used for each sampling situation will be k = 5 or 6. The number of tasks, n, can be as large as desired.

In the data layout of Table 1 X_{ij} denotes the response (observed classification) by person j on task i. The model in this analysis is

$$X_{ij} = \pi_i + \varepsilon_{ij}$$

where π_i is the true magnitude of the characteristic (task) being measured and ε_{ij} is the "error" in the response (classification) of job i by person j. For a fixed task π_i is assumed to be constant whereas ε_{ij} is assumed to vary, i.e. there are differences in how different individuals classify a particular task i. It is assumed that π_i and ε_{ij} are independent normally distributed random variables with variances σ_π^2 and σ_ε^2 respectively. The one-way analysis of variance (ANOVA) technique can be used to estimate reliability of measurements. In the present situation the reliability

of the mean response of L measurements (i.e., L persons) is defined as[1]:

TABLE 1

PROPOSED RELIABILITY METHOD DESIGN

	Group Selected Individuals (j)						
	1	2	3	.	.	.	k
Tasks (i)							
1	X_{11}	X_{12}	X_{13}	.	.	.	X_{1k}
2	X_{21}						
3	X_{31}						
.							
.							
.							
n	X_{n1}						X_{nk}

$$\rho_L = \sigma_\pi^2 / (\sigma_\pi^2 + \sigma_\varepsilon^2/L) \quad .$$

The variances σ_π^2 and σ_ε^2 appear in the expected mean squares in the one-way ANOVA. The reliability ρ_L can thus be estimated by using the computer mean squares in a one-way ANOVA table. For example, consider the case of n = 20 tasks and k = 6 individuals. The following ANOVA table can be constructed by standard techniques. The degree of freedom for within tasks are n(k-1) = 20(5) = 100 and those for between tasks are n - 1 = 19.

---

[1]Winer, B.J. Statistical Principles in Experimental Design (second edition). McGraw-Hill, 1971, p. 285.

Source	SS	df	MS	F
Within Tasks	SS_ε	100	MS_ε	
Between Tasks	SS_ε	19	MS_π	MS_π/MS_ε
Total	SS	119		

The reliability ρ_L is estimated by $\hat{\rho}_L = 1 = MS_\varepsilon/MS_\pi = 1 - F^{-1}$ where $F = MS_\pi/MS_\varepsilon$. Thus it is seen that, if $F_\rho \geq 10$, then $\rho > 0.90$. In this case it can be claimed that this task has been validated at the 90 percent level, since the reliability of this question is equivalent to the reliability of the mean response to this question.

It should be noted that the same basic model discussed above can be used in estimating reliability of measurements for sampling situations in specific circumstances such as for locations of interest, and for various types of mission bases.

SAMPLE SELECTION FOR GROSS ADMINISTRATION OF THE SURVEY QUESTIONNAIRE

Once the survey questionnaire has been validated for reliability, then gross Air Force Administration will be undertaken. The AFSCs' tasks to be surveyed will be selected with the following considerations regarding the particular AFSC, Air Force Base, and environmental extremes, and the mission. All AFSCs which need to be surveyed, will be surveyed.

Let us now consider the number of persons to be surveyed within each AFSC prior to determining the precise composition of this sample.

From the validation results, let $\hat{\rho}^2$ denote the within task variance estimate (error variance), where the tasks which have been validated at the 90 percent level as previously described. Further let $\hat{\mu}$ denote the average response over all tasks and over all validated questions on the trial administration of the survey instrument. In order to estimate the true average mean response, μ, with an error no larger than 5 percent with 95 percent confidence implies that we must have

$$2(1.96)\ \frac{\hat{\sigma}}{\sqrt{n}} \leq \cdot 10\ \hat{\mu}$$

which in turn indicates the survey sample size should be

$$n = \frac{(3.84)\ \hat{\sigma}^2}{(0.0025)\hat{\mu}^2} \quad ,$$

for each of the AFSCs needed to be surveyed. For example, suppose that $\hat{\mu}$ and $\hat{\sigma}$ are found to be 3.0 (from a Likert five-step scale between 1 and 5) and 0.5, respectively. In this case, it will be necessary to survey an average of 43 persons per selected AFSC computed as follows:

$$n = \frac{(3.84)\ (0.25)}{(0.0025)\ (9.0)} = 43$$

It is noted here that the estimated survey error variance $\hat{\sigma}^2$ defined above may have to be inflated by a factor, of say 0.5, to account for any factor such as the trial survey administration which may be entirely conducted at a single Air Force Base. Thus, response differences due to such factors as adverse environment, location differences, etc. are not reflected in this error variance estimate.

The composition of the per AFSC sample size n will now be discussed. Let N_1 and N_2 denote the number of Air Force enlisted personnel which are males and females, respectively. Then, roughly $N_1 n/(N_1 + N_2)$ males and $N_2 n/(N_1 + N_2)$ females will be surveyed per AFSC where possible. Also, suppose that there are M Air Force bases where this AFSC code is present. Further, let M_i denote the number of persons in this AFSC at the ith base, i = 1, 2, ... M. Then, the number of persons to be surveyed at base i is, roughly $nM_i / \sum_{i=1}^{M} M_i$. That is, proportional allocation with regard to the number of persons per AFSC per base is used to identify the particular sample composition for each AFSC.

It is proposed that both sex and AFSC distribution be considered as described above to hand pick the required sample of size n for each AFSC designation. Although this will be somewhat time consuming, this procedure will permit better control over the sample population for such other variables as experience and grade rating.

In achieving reliability of the questionnaire, it is assumed that validity will also be achieved. However, if separate validity is deemed necessary, then actual task sampling for validity will be performed. A sample of the questionnaire tasks will be taken as the tasks sample and these tasks will be analyzed in detail to obtain accurate data on their demands. From this analysis, it will be possible to classify them according to the operational scale defined in phase I. Comparison between the questionnaire classification and the classification based on the detailed analysis will provide the needed data for testing the validity of the survey.

APPENDIX 3

ARMED FORCES EXAMINATION AND ENLISTMENT STATIONS (AFEES) AND BASIC MILITARY TRAINING (BMT) SCHEDULE ANALYSES

Implementation of the Strength Aptitude Test Battery (SATB) at the AFEES and BMT operations will require planning. In order to implement the SATB, with a minimum of interruptions, delays, and cost, schedule analyses of both operations are needed. These analyses are required in order to:

(1) Clearly understand the existing schedule and its requirements,

(2) Compile a comprehensive list of activities which may be affected and therefore must be considered in the analyses, and

(3) Determine the best method(s) of implementing the SATB into the AFEES and BMT schedules with minimum adverse effects.

Any implementation of the activity will undoubtedly have an affect on the operation of the unit and thus require coordination. The schedule analyses will be based on the assumption that the SATB will be administered only to Air Force potential recruits at the AFEES and to all recruits at BMT.

Based on the initial assumptions, the schedule analyses will consider the following areas of concern:

(1) Physical changes

(2) Queue problems

(3) Administrative changes.

Topics (not inclusive) within each area are:

(1) Physical changes:

  (a) Space requirements: testing areas, equipment storage, and supplies.

  (b) Number of test units and location within the facility.

(2) Queue problems:

  (a) Phasing individuals in and out of queues.

  (b) Placement in existing queues: waiting periods, simultaneous administration, using multi-testing stations to maintain flow.

(3) Administrative changes:

(a) Time: Equipment breakdown, physician evaluation if needed, SATB administration.

(b) Paperwork: Recording of results, tabulation, and dissimination.

(c) Personnel for testing, calibration, and maintenance.

APPENDIX 4

DEFINITIONS OF MAXIMUM SAFE STRESS LEVELS AND STRENGTH/STAMINA TESTS INVENTORY

DEFINITION OF MAXIMUM SAFE STRESS LEVELS FOR DYNAMIC STRENGTH TESTING

Operational Precautions

Requirements Concerning Personnel

The personnel administering dynamic strength tests must be thoroughly trained in the procedures for test administration and for providing appropriate emergency first aid. While the presence of a physician is not required, emergency assistance should be readily available.

Monitoring Equipment

The subject's blood pressure and pulse rate should be measured prior to administration of tests and repeated if any symptoms of difficulty become evident. Continuous heart rate monitoring is not required. Personnel may check pulse rate either by hand or with a pulse meter.

Operational Procedures

The dynamic strength tests must be carefully administered to ensure subject safety and uniformity of results. The subject must understand the correct body position and movements required by the test. Correct posture and movement may need to be demonstrated. Several trials may be allowed to instruct the subject. All movements should be done in a smooth and rhythmic fashion. No sudden jerking should be allowed. The subject must understand that he is to terminate the activity if he feels continuation will cause injury or severe disease and that he may do so without fear of penalty.

Except for the simplest tests which require no or immobile equipment, the operator should have at least one assistant for test administration. If weight lifting is involved, two assistants may be required.

A minimum of three to five minutes should be allowed between tests involving the same muscle groups or between tests to the limit of local muscle endurance.

Clinical Precautions

Medical Examination

A medical history should be taken prior to test administration. Subjects with any present complaints (contagious disease, arthritis, etc.) or a recent history (within six months) of chest pain, surgery,

hernia, high blood pressure, etc. should receive a physician's permission (which may require examination) prior to test administration. If the subject is under 40 and has no clinical symptoms, the testing may be done without a physical examination.

Contraindications for Dynamic Strength Testing

Dynamic strength tests should not be made if the subject has:

(1) Not received physician's consent if required (see conditions above),

(2) Muscle soreness or spasm,

(3) Joint pain,

(4) Resting heart rate more than 100 beats/min., and

(5) Oral temperature more than 37.5°C.

Dynamic strength tests will be less accurate if the subject has:

(1) Not had adequate sleep,

(2) Not fully recovered from last severe physical exertion, and

(3) Had anything to eat, drink, or smoke for at least two hours.

Indications for Stopping Testing

If no indications of difficulty occur during the testing, the testing is stopped when:

(1) The subject has repeated the required movements as many times as possible without causing extreme distress, or

(2) The subject has repeated the required movements as many times as possible within the time limit.

In addition, the test should be stopped and any appropriate precautionary measures started when any of the following conditions are observed:

(1) The subject is unable to complete a full cycle of movement in the proper fashion or with less than two seconds pause,

(2) The subject is unable to proceed because of distress,

(3) The subject shows symptoms of distress such as chest pain, severe dyspnea, facial pallor, staggering, confusion, etc.,

(4) The systolic pressure exceeds 240-250 mm Hg,

(5) The diastolic pressure exceeds 125 mm Hg, and

(6) The subject has a heart rate greater than 80 percent of the maximum estimated for his age group.

DEFINITION OF MAXIMUM SAFE STRESS LEVELS FOR STATIC STRENGTH TESTING

Operational Requirements

Requirements Concerning Personnel

The personnel administering static strength tests should be thoroughly trained in the test procedures. The instructions to the subjects and the use of any equipment must be such that the tests are safely and correctly administered in a manner that results in uniform results.

Monitoring Equipment

Blood pressure and pulse rate should be checked prior to taking the test battery and the measurements repeated if any symptoms of difficulty become evident. Continuous heart rate monitoring is not required. Personnel may check pulse rate either by hand or with a pulse meter.

Operational Procedures

Static measurements of maximum strengths using a dynamometer or load cell must be carefully administered to ensure uniformity of results. The subject should be informed about the test purpose and procedures in a factual and unemotional manner. Factors which can alter performance such as fear, noise, competition, spectators, etc. should be avoided. The subject should always be instructed to "increase to maximum exertion (without jerk) in about one second and maintain this effort during a four second count." No feedback should be given during exertion but between tests the subject may be informed about his general performance in noncomparative, qualitative, and positive terms. A minimum rest period of two to three minutes should be allowed between related efforts. When scoring strength measures on a recorder output, the transient periods (about one second each) before and after steady exertion are ignored. The strength datum used is the mean score recorded during the first three seconds of steady exertion. When using a dynamometer with a maximum reading indicator instead of recorder output, the setting is carefully recorded prior to resetting of the instrument. Three measurements

are taken (with a rest period between them) and then the scores averaged.

For static endurance tests, the time that the body is held in a particular position is measured instead of force. The subject should be shown the proper position prior to the test. If the body must be kept in a particular angle, a trial attempt in that position should be allowed during which corrections to posture can be explained. The subject should be instructed to hold the position as long as possible without experiencing extreme strain or pain.

Clinical Precautions

Medical Examination

A medical history should be taken prior to test administration. Subjects with any present complaints (contagious disease, arthritis, etc.) or a recent history (within six months) of chest pain, surgery, hernia, high blood pressure, etc. should receive a physician's permission (which may require examination) prior to test administration. If the subject is under 40 and has no clinical symptoms, the testing may be done without a physical examination.

Contraindications for Static Strength Testing

Static strength tests should not be made if the subject has:

(1) Not received physician's consent if required (see conditions above),

(2) Muscle soreness or spasm,

(3) Joint pain,

(4) Resting heart rate more than 100 beats/min., and

(5) Oral temperature more than 37.5°C.

The static strength test will not be as accurate if the subject has:

(1) Not had adequate sleep,

(2) Not fully recovered from last severe physical exertion, and

(3) Had anything to eat, drink, or smoke for at least two hours.

Indications for Stopping Testing

If no indications of difficulty occur during the testing, the testing is stopped when:

(1) The subject has reached and held maximum strength for four seconds when the maximum force developed is being measured, or

(2) The subject has held his body in the required configuration as long as possible without causing distress when the maximum endurance is being measured.

In addition, the test should be stopped and any appropriate precautionary measures started when any of the following conditions are observed:

(1) The subject is unable to proceed because of distress,

(2) The subject shows symptoms of distress such as chest pain, severe dyspnea, facial apllor, staggering, confusion, etc.,

(3) The systolic pressure exceeds 240-250 mm Hg,

(4) The distolic pressure exceeds 125 mm Hg, and

(5) The subject has a heart rate greater than 80 percent of the maximum estimated for his age group.

DEFINITION OF MAXIMUM SAFE STRESS LEVELS
DURING CARDIOVASCULAR TESTING

Operational Precautions

Requirements Concerning Personnel

The personnel must be well trained for this specialized test. Maximal or stress tests for oxygen uptake require the presence of a physician (or qualified paramedic if a physician is not present but readily available). Less stressful tests may be performed by experienced personnel with a physician on call. In both types of testing, the personnel must be able to recognize the signs and symptoms of impending difficulties and be able to initiate appropriate precautionary procedures immediately. They should be able to recognize basic abnormalities in the ECG.

Monitoring Equipment

Equipment should be available for the monitoring of blood pressure during exercise testing. While continuous ECG monitoring is always desirable, it is required during maximal tests of oxygen uptake or when a test will be stopped when (or if) the heart rate reaches a predetermined value. If the nature of the test is such

that a continuous ECG is not necessary, a pulse meter may be used for monitoring purposes or the test personnel must be experienced in counting the pulse rate gy palpitation. For some tests, measurement of oxygen consumption will also be required. Monitoring should continue for several minutes after cessation or exercise.

Operational Procedures

These procedures are for maximal tests. They should be modified as appropriate for submaximal tests since submaximal tests do not require as stringent controls.

The cardiovascular tests must be carefully administered to ensure subject safety and uniformity of results.

The running type of tests require no subject familiarization with equipment. These should be preceeded by a brief period doing calisthenics or short sprints to loosen and warm-up muscles. The test may then be run after a short rest period.

For tests involving the stepping bench, bicycle ergometer, or treadmill, the following procedures should be used.

The subjects report to the laboratory in light gym clothing and rubber-soled shoes, having abstained from food, coffee, tobacco, and so on, for at least two hours.

A preliminary period of at least 15 minutes of rest should precede the exercise test. During this period the subject sits comfortably in a chair while physiological baseline measurements are established.

The very first test of any individual as well as all subsequent repeats become sufficiently reliable if the actual test is preceded by a short period of exercise at a low work intensity. This accommodation period, three minutes duration is enough, serves:

(1) To familiarize the subject with the equipment and with the type of work required,

(2) To pretest the subject's physiological response to a workload of approximately four Mets, or an initial heart rate response of approximately 100 beats/minute, and

(3) To hasten the proper physiological adjustments to the actual test work.

The accommodation period is followed by two minutes of comfortable rest in a chair while the necessary technical adjustments are effected.

The test begins with the work intensity employed in the accommodation period, (approximately four Mets), and the subject continues to exercise without interruption until the test is completed.

Physiological monitoring should continue at least three minutes after the test is finished. The subject should be seated in a chair, preferably with legs raised.

Clinical Precautions

Medical Examination of the Subjects

A thorough medical history should be obtained prior to testing. This should be followed by a physical examination that includes the cardiorespiratory system with an ECG evaluation.

Contraindications for
Cardiovascular Testing

Conditions that are contraindications for exercise testing include:

(1) Lack of physician's permission,

(2) Presence of infectious diseases,

(3) Less than three months' freedom from myocardial infarction, myocarditis, or angina pectoris,

(4) Presence of ECG aberrations,

(5) Resting heart rate greater than 100 beats/minute,

(6) Oral temperature greater than 37.5°C, and

(7) Unstable metabolic conditions.

The cardiovascular testing will be less accurate if the subject has:

(1) Not had adequate sleep,

(2) Not recovered from severe physical exercise, and

(3) Had less than two hours since eating, drinking, or smoking.

Indications for Stopping
Cardiovascular Testing

If no indications of difficulty occur during the testing, the testing is stopped when:

(1) The subject in a maximal test of oxygen uptake reaches the required maximum VO_2 plateau (two successive readings not differing more than 5 percent), or

(2) The subject in a submaximal test reaches a predetermined heart rate, not to exceed 80 percent of the maximum estimated for the subject's age group.

The testing should be immediately stopped and the appropriate precautionary measures instigated when any of the following conditions are observed:

(1) The subject is unable to proceed because of distress,

(2) The pulse pressure declines in spite of increasing intensity of work,

(3) The systolic pressure exceeds 240-250 mm Hg,

(4) The diastolic pressure exceeds 125 mm Hg,

(5) Symptoms of distress such as chest pain; severe dyspnea; intermittent claudication,

(6) Clinical signs of hypoxia (e.g., facial pallor, cyanosis, staggering, confusion, unresponsiveness to inquiries), and

(7) ECG aberrations such as paroxysmal superventricular or ventricular dysrhythmia, successive ventricular premature complexes before the end of T wave, conduction disturbances other than a slight AV block, S-T depressions of horizontal or descending type greater than 0.3 mv.

STRENGTH/STAMINA TESTS INVENTORY

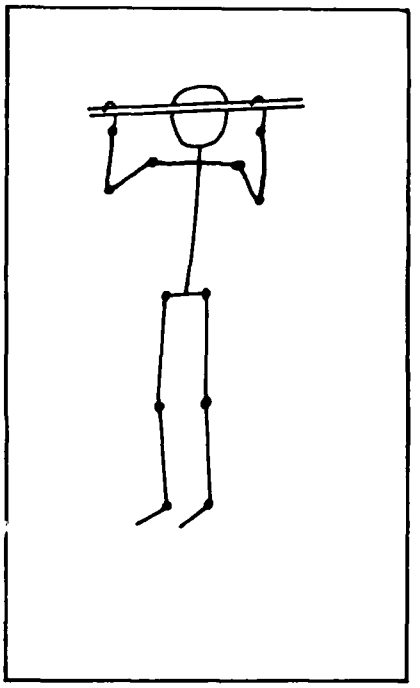
TEST NAME:
Pull-Up/Chin-Up

SOURCE:
Larson, 1940

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Flexion.

EQUIPMENT NEEDED:
Horizontal bar (2 - 5 cm diameter), step stool, block of magnesium chalk, floor mat (optional safety feature).

PROCEDURE:
Subject uses step stool to reach bar after chalking hands and hangs fully extended from bar. Either a forward or backward grip is allowed as long as there is consistancy for all subjects (the palms backwards grip yields 2 - 2 1/2 more chins per subject on the average). At the signal to start, the subject pulls himself up until his chin is over the bar, then lowers himself again to the fully extended position. Subject repeats this in as smooth a manner as possible; no swinging or kicking of the legs is permitted. The examiner may need to stand in front of the subject to steady the legs. No partial credit is allowed. The exercise should be a smooth and continuous procedure.



SCORING:
Score = Number of successfully completed chins.

COMMENTS:
Several versions of this procedure are available, including ones that employ a modified position. Rings may be used instead of a horizontal bar.

TEST VARIATIONS:
Larson, 1974; Fleishman, 1964; Mathews, 1973; Sharkey and Jakkula, 1977.

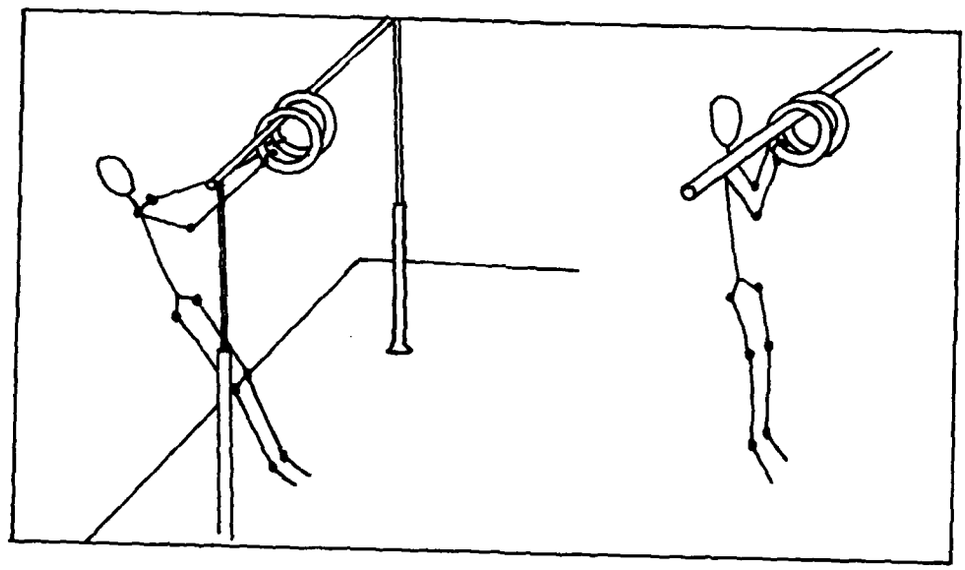
TEST NAME:
Pull-Ups - Modified

SOURCE:
Mathews, 1973

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Flexion.

EQUIPMENT NEEDED:
Rings attached to an adjustable height bar.

PROCEDURE:
Subject grasps rings attached to an adjustable bar. The bar has been adjusted to be even with the subject's sternal apex. The subject grasps the rings and leans back so that the body is at a right angle to the rings. He then pulls the body up to the rings repeatedly as many times as possible.



SCORING:
Score = Number of completed pull-ups.

COMMENTS:
This test is a modified test used for girls by the Physical Fitness Index.

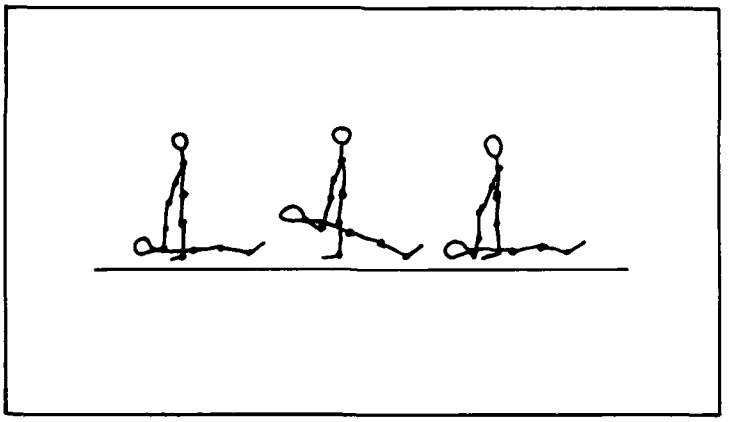
TEST NAME:
Straddle Chinning

SOURCE:
Bookwalter, 1943

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Flexion.

EQUIPMENT NEEDED:
A partner of approximately the same height.

PROCEDURE:
The class members should first be paired according to size and then counted off in groups of two. The number ones lie on their backs, arms sideward, with shoulders level on the floor. Upper arms are bent to vertical. Number two stand astride and facing number ones, with feet outside and touching elbows of number ones. Partners clasp hands, bent-finger hold, and number ones chin upward as often as possible. The chest should meet firm resistance with partners thighs each time. Both partners should keep legs and back straight. Arms of supporting partner are straight throughout. Partners may change places and repeat as before.



SCORING:
Score = Number of completed chins.

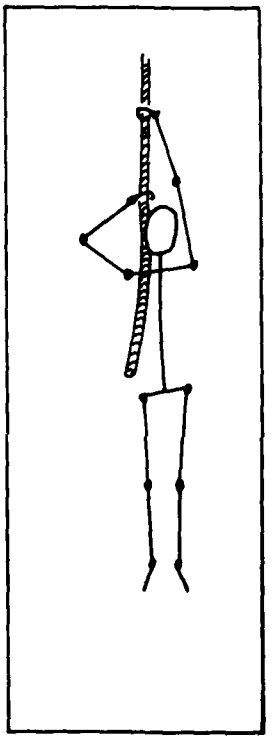
TEST NAME:
Rope Climb

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Flexion.

EQUIPMENT NEEDED:
A rope, 20 feet high with adhesive tape marks every foot and with a colored tape every 5 feet, stopwatch.

PROCEDURE:
The subject grasps the rope as high as possible. This reach height is recorded. At the signal, the subject pulls himself up the rope as fast and as high as possible in six seconds. The subject is not allowed to jump up onto the rope, or to grasp the rope with knees or legs. The emphasis must be on the arms. At the signal to stop, after six seconds of climbing, his highest reach on the rope is recorded as the climbing height. One examiner controls the stopwatch while another watches the rope at all times.



SCORING:
Score = Climbing height in six seconds minus the reach height.

TEST VARIATIONS:
Johnson and Nelson, 1969.

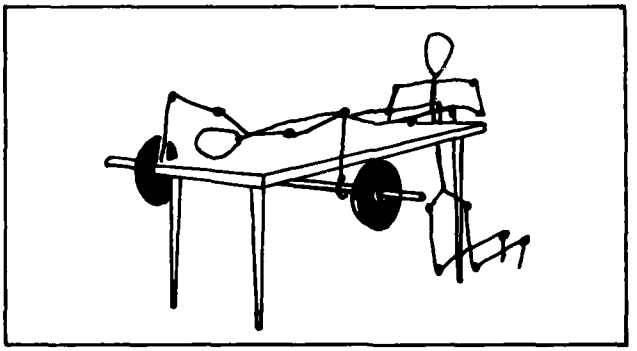
TEST NAME:
Pull Weights - Arms

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Flexion.

EQUIPMENT NEEDED:
Bench (4 foot high x 6 foot long x 1 foot wide), 17 lb. bar with 20 lb. weights, stopwatch.

PROCEDURE:
The subject lies face down on the bench and grips the barbell underneath the bench with palms facing down. The hands are spaced wide enough so that with the bar pulled up to the bench, the subject's forearms are perpendicular to the floor. Starting with the arms extended downward, the subject pulls the bar up until it touches the bench and then lowers it to the fully extended position. The subject is allowed to perform this maneuver twice for familiarization. Then, starting from the fully extended position, at the signal the subject pulls the bar up to touch the bench and lowers it as many times as possible in 20 seconds. The subject is to use smooth motions and not to bounce the bar off of the bottom of the bench. The legs are held down by an assistant.



SCORING:
Score = Number of times the barbell is returned to the extended position.

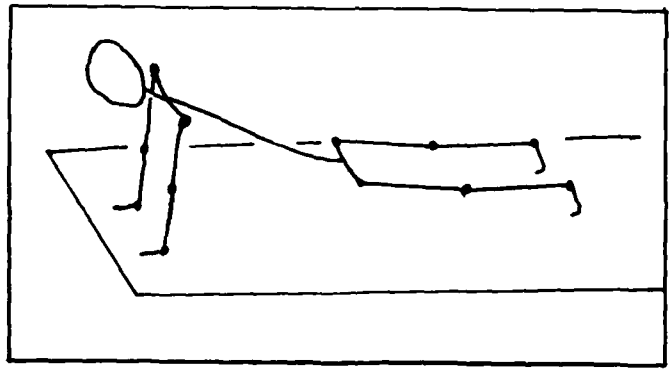
TEST NAME:
Push-Ups

SOURCE:
Mathews, 1973

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Extension.

EQUIPMENT NEEDED:
Floor mat

PROCEDURE:
The subject lies in a prone position on the floor with hands beside the chest so that the forearms make a 90° angle with the floor. The fingers are pointed forward and the feet are together with the body straight. At the signal, the body is raised until the arms are straight and then lowered again until only chin and chest touch. The subject repeats the push-up as many times as possible without holding any position more than 2 seconds. The back is kept straight at all times.



SCORING:
Score = Number of completed push-ups.

COMMENTS:
The feet are used as a pivot point for males, while the knees are used as a pivot point for females.

TEST VARIATIONS:
Sharkey and Jakkula, 1977; Fleishman, 1964.

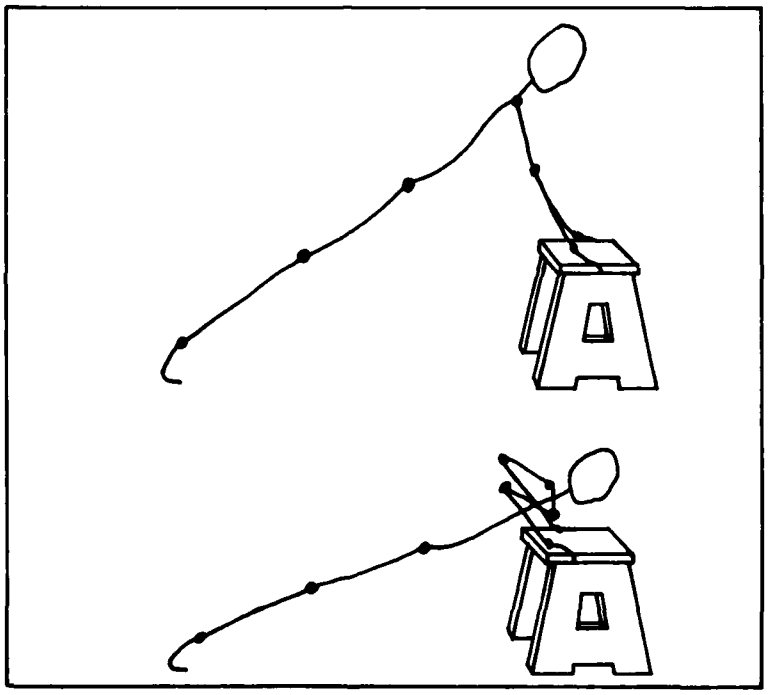
TEST NAME:
Push-Ups - Modified

SOURCE:
Mathews, 1973

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Extension.

EQUIPMENT NEEDED:
Stall Bar Bench, 13 inches high.

PROCEDURE:
The subject assumes a front leaning rest position with the arms straight. With head up and back straight, the subject lowers the body so that the chest touches (or nearly so) the bench; and then returns to the arms extended position. This is repeated as many times as possible.



SCORING:
Score = Number of completed push-ups.

COMMENTS:
This test is a modified procedure used for females in the Physical Fitness Index.

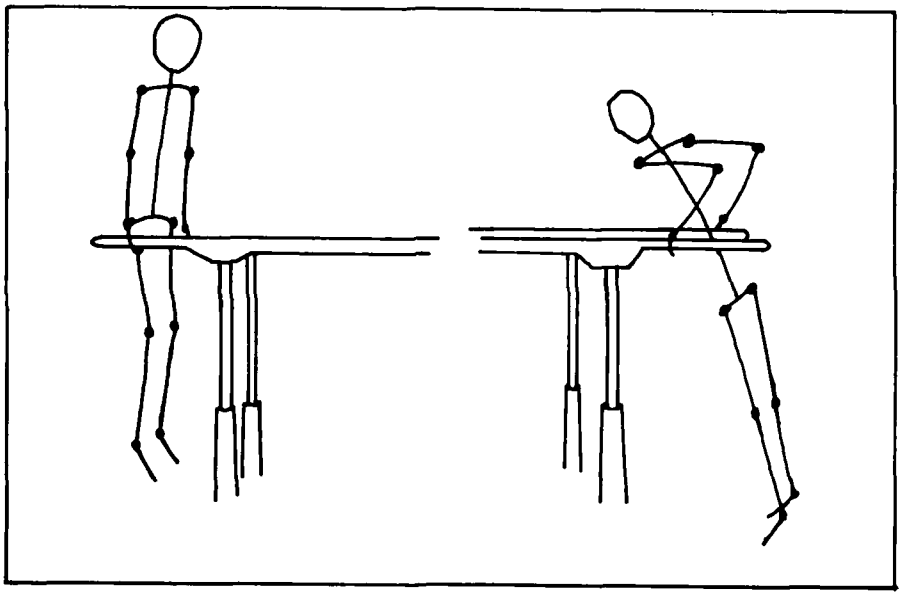
TEST NAME:
Dips

SOURCE:
Larson, 1940

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Extension.

EQUIPMENT NEEDED:
Adjustable height parallel bars.

PROCEDURE:
The subject supports himself with arms straight between the parallel bars which have been adjusted to shoulder height. The subject then lowers his body to the point where the elbows form a right angle. The examiner notes this place with a fist which the subject touches each time he dips. The subject raises and lowers the body as many times as possible.



SCORING:
One count is given for mounting the bars. Then, an additional count for each time the body is returned to the arms extended position. Up to 4 half-counts are allowed.

COMMENTS:
This text is used for males in the Physical Fitness Index and the score is combined with the pull-up score to give an arm strength score.

TEST VARIATIONS:
Fleishman, 1964.

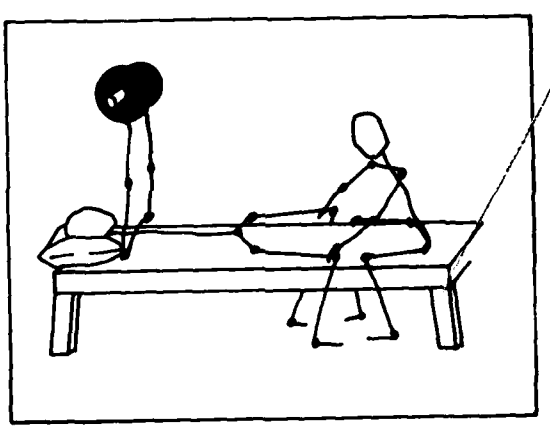
TEST NAME:
Push Weights - Arms

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength - Extension.

EQUIPMENT NEEDED:
Bench, 37 lb. barbell, stopwatch.

PROCEDURE:
Subject lies face up on bench with feet on the floor. Subject is handed a 37 lb. barbell, holding it with palms facing feet. With the barbell held close to the chest, the hands are spaced just wide enough so that the forearms are perpendicular to the floor. The subject presses the barbell twice for familiarization. Then, starting with the arms extended, at the signal to start, the subject lowers the barbell to within an inch of the chest, and then presses it back to the starting position as many times as possible in 20 seconds. The knees are held down during the testing.



SCORING:
Score = Number of times the barbell is returned to the start position in 20 seconds.

TEST VARIATIONS:
Johnson and Nelson, 1969.

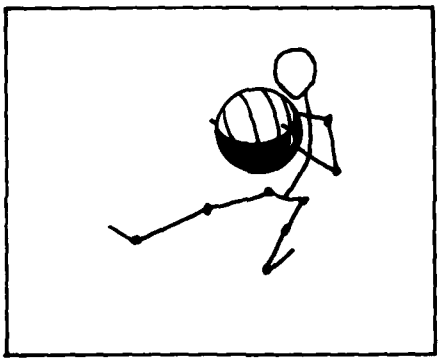
TEST NAME:
Medicine Ball Put - Sitting

SOURCE:
McHone et al., 1952

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength (explosive) - Extension.

EQUIPMENT NEEDED:
Nine lb. medicine ball, adhesive tape, tape measure.

PROCEDURE:
The subject sits so that the hands are even with the base line when outstretched. The subject grasps the medicine ball with his palms placed on the tape mark on each side of the ball. The subject is not to put the hands behind the ball, nor cock the wrists when throwing. The subject brings the ball back to the chest and then pushes out from the body as far as possible to throw the ball. The subject is not allowed to move from the sitting position. The subject is given three tries.



SCORING:
The distance that the ball is thrown in the best of the three trials.

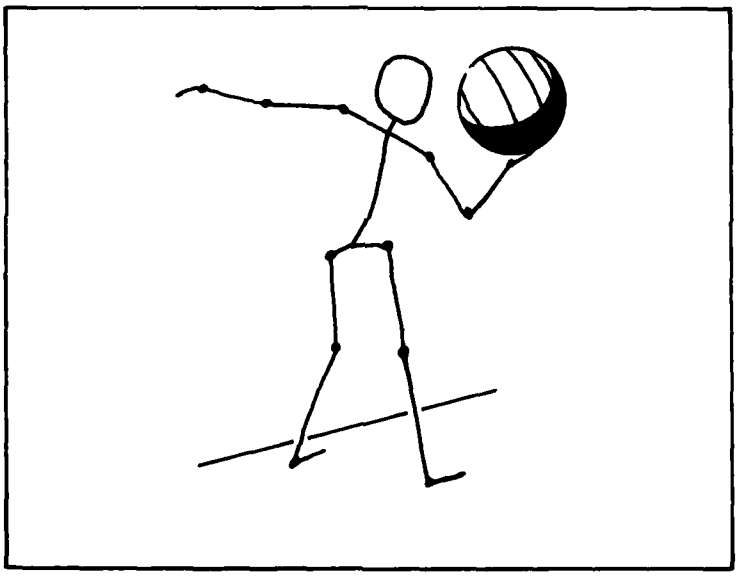
TEST NAME:
Medicine Ball Put - Standing

SOURCE:
McHone et al., 1952

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength (Explosive) - Extension

EQUIPMENT NEEDED:
9 lb. Medicine Ball, Tape Measure

PROCEDURE:
The subject holds the ball in the preferred hand and balances it with the other hand. The forward foot is placed in back of the base line and the other foot is positioned in a comfortable position. Once in place, the subject is not permitted to move the feet but can twist the body. The subject throws the ball as far as possible with one hand. The subject is allowed 3 correct throws.



SCORING:
Score = The distance in feet of the best throw.

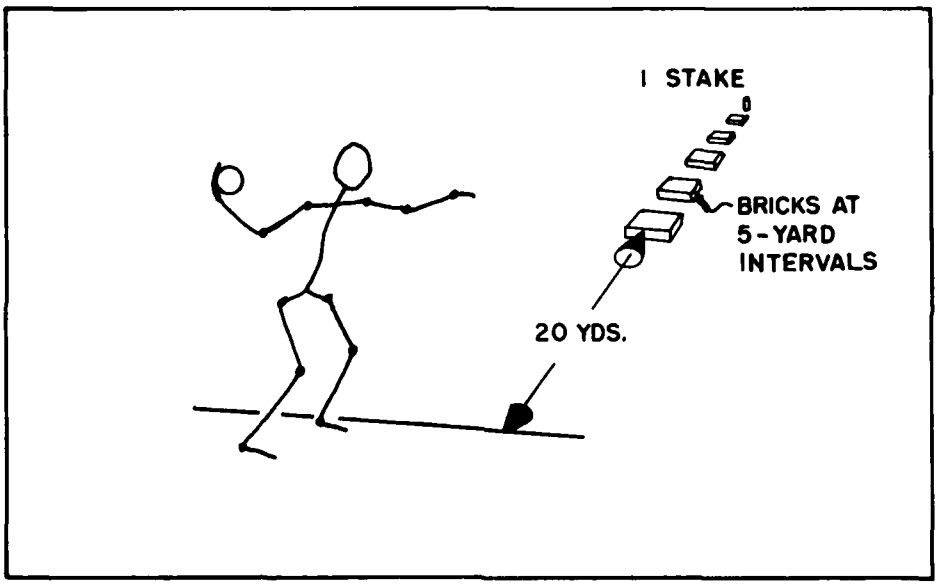
TEST NAME:
Softball Throw

SOURCE:
Johnson and Nelson, 1969

FUNCTION(S) MEASURED:
Arm/Shoulder - Dynamic Strength (Explosive) - Extension.

EQUIPMENT NEEDED:
Open field, approximately 100 yards long; 12 inch standard softball; tape measure.

PROCEDURE:
The subject throws the softball overhand as far as possible without moving the feet. Three trials are allowed. The distance the ball is thrown is measured to the nearest foot.



SCORING:
Score = Distance in feet for the best of the three trials.

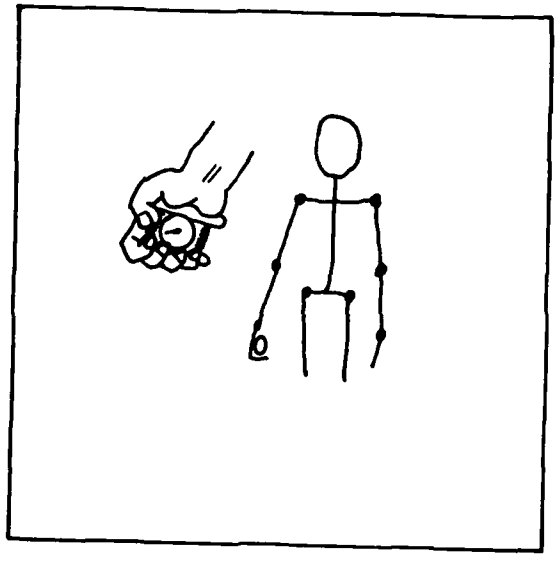
TEST NAME:
Grip Strength

SOURCE:
Clarke, 1950

FUNCTION(S) MEASURED:
Arm/Shoulder - Static Strength - Flexion.

EQUIPMENT NEEDED:
Grip Dynamometer

PROCEDURE:
Subject takes the dynamometer in the preferred hand and holds it in line with the forearm by the thigh, with the weight of the instrument on the second joint of the fingers. With the dynamometer gripped between the fingers and the palm at the base of the hand, the subject holds it away from the body and squeezes vigorously.



SCORING:
Score = The best of two trials measured in pounds or kilograms.

COMMENTS:
At least one minute should be allowed between trials.

TEST VARIATIONS:
Mathews, 1973; Fleishman, 1964.

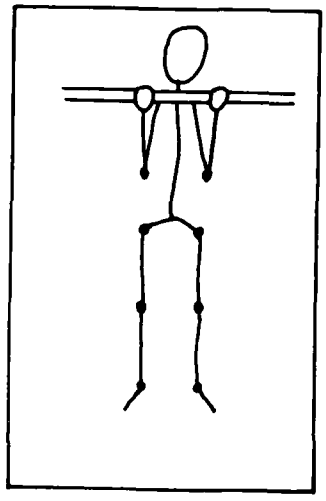
TEST NAME:
Flexed-Arm Hang

SOURCE:
McHone et al., 1952.

FUNCTION(S) MEASURED:
Arm/Shoulder - Static Strength - Flexion.

EQUIPMENT NEEDED:
Horizontal bar (2-5 cm diameter), step stool, block of magnesium chalk, stopwatch.

PROCEDURE:
The subject steps from the stool and clasps the bar with a palms facing forward grasp. The arms are fully flexed with the chin just above the bar. At the signal when the subject is in position and ready, the last supportive foot is removed from the stool and the subject hangs with the arms flexed. The chin is held just above the bar for as long as possible.



SCORING:
Score = The total time in seconds that correct position is held.

COMMENTS:
This test is used for females in the Basic Physical Performance Test instead of the pull-ups that are used for males.

TEST VARIATIONS:
Fleishman, 1964.

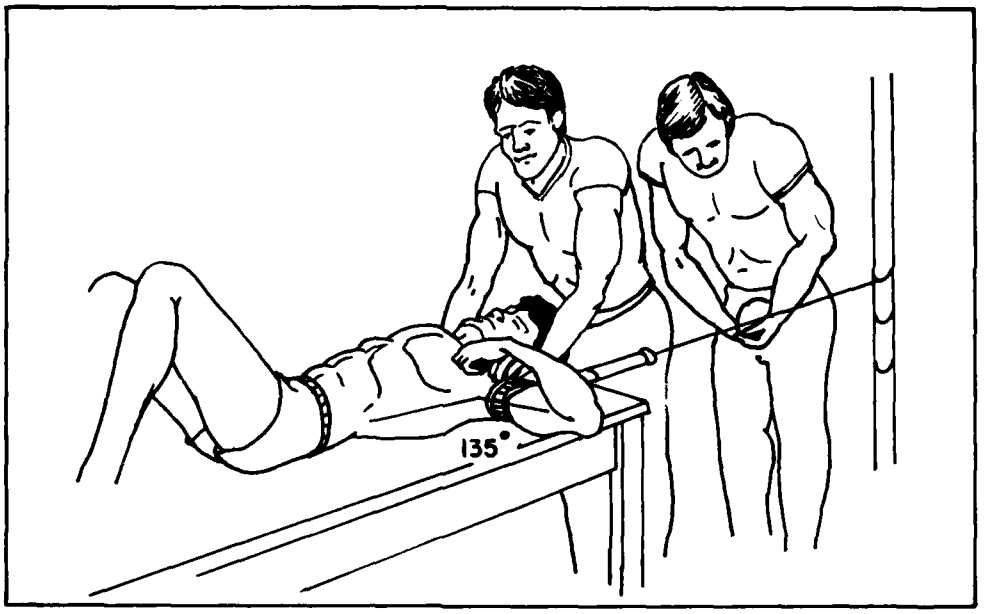
TEST NAME:
Shoulder Flexion

SOURCE:
Clarke and Clarke, 1963

FUNCTION(S) MEASURED:
Arm/Shoulder - Static Strength - Flexion.

EQUIPMENT NEEDED:
Dynamometer, load cell, or tensiometer; goniometer; testing table.

PROCEDURE:
The subject lies supine on the test table with knees flexed and feet on the table. The free arm is on the chest while the tested arm is flexed 135° at the shoulder. The elbow is in a thrust position with the strap to the load cell or dynamometer around the upper arm. The subject exerts as much force as possible in a static flexion.



SCORING:
Score = Pounds of force exerted.

COMMENTS:
Use of an alternate position with the forearm across the chest and the hand held low towards the opposite shoulder will result in a lower strength score.

TEST VARIATIONS:
Clarke, 1966

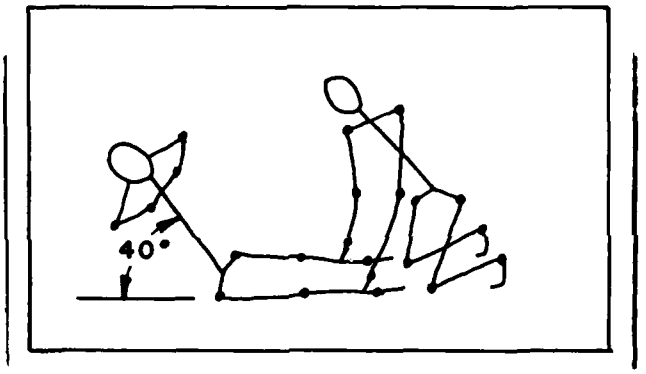
TEST NAME:
Hold Half Push-Up

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Arm/Shoulder - Static Strength - Extension.

EQUIPMENT NEEDED:
Stopwatch, floor mat.

PROCEDURE:
The subject lays prone with legs together, hands beside chest, and fingers forward with the hands far enough apart for the forearms to make a right angle with the floor. At the signal the subject does a push-up until there is a 90 degree angle between the forearm and the upper arm. This position is held with the back, legs, neck and head in a straight line for as long as possible.



SCORING:
Score = Number of seconds that the correct position is maintained.

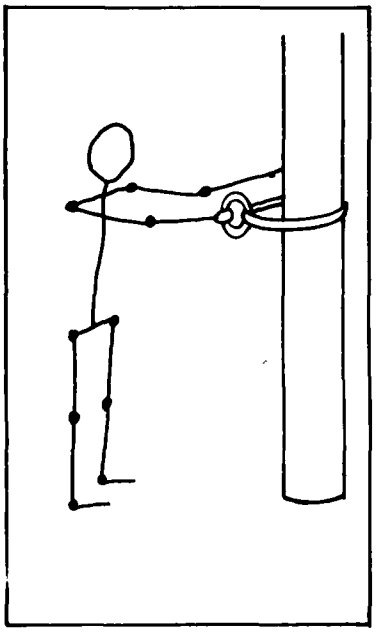
TEST NAME:
Arm Pull

SOURCE:
Fleishman, 1964

FUNCTIONS(S) MEASURED:
Arm/Shoulder - Static Strength - Extension/Flexion.

EQUIPMENT NEEDED:
Dynamometer, attachment strap, pole.

PROCEDURE:
The dynamometer is attached to the pole at the height of the subject's shoulder. The attachment strap is adjusted for each subject's arm length. The subject grips the handle of the dynamometer using the stronger arm and braces themselves against the pole with the other. The subject pulls as hard as possible while keeping the forearm and legs straight. The subject is allowed three trials with a minimum of 30 seconds between pulls.



SCORING:
Score = Pounds force recorded for the best of the three trials.

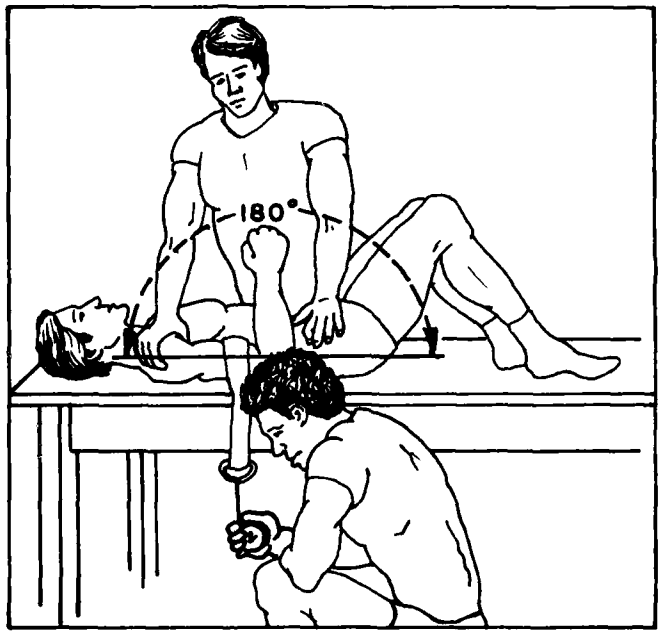
TEST NAME:
Shoulder Adduction

SOURCE:
Clarke and Clarke, 1963

FUNCTION(S) MEASURED:
Arm/Shoulder - Static Strength - Adduction.

EQUIPMENT NEEDED:
Dynamometer, load cell, tensiometer; goniometer; table table.

PROCEDURE:
The subject lies in a supine position on the table with knees flexed and feet flat on table. The tested arm is adducted at the shoulder 160°. The forearm is in a thrust position with the strap to the load cell or dynamometer around the upper arm. At the signal, the subject attempts to adduct the upper arm, exerting as much force as possible.



SCORING:
Score = Pounds of force exerted.

COMMENTS:
Alternate procedure does not result in as high a strength measurement.

TEST VARIATIONS:
Clarke, 1966.

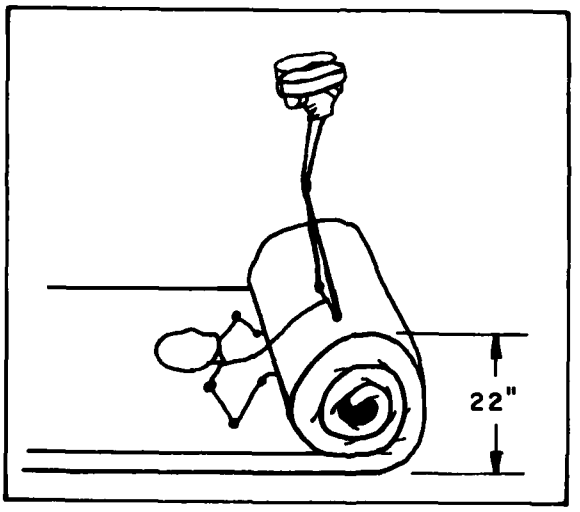
TEST NAME:
Push Weights - Feet

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Leg/Hip - Dynamic Strength - Extension.

EQUIPMENT NEEDED:
Quadriceps boots, bar weights totaling 27 lbs., stopwatch, 4 inch floor mat.

PROCEDURE:
One end of the floor mat is rolled to make a 22 inch diameter roll. The subject lies on his back with this roll under the small of the back. The subject balances the boots with the weights attached over his head. The subject practices lowering the weights as far as possible by bringing the knees down up to the chest and then extending the legs to balance the weight again over the head. At the signal, the subject lowers and raises the weights as many times as possible in 20 seconds.



SCORING:
Score = Number of times the weight is returned to the starting position in 20 seconds.

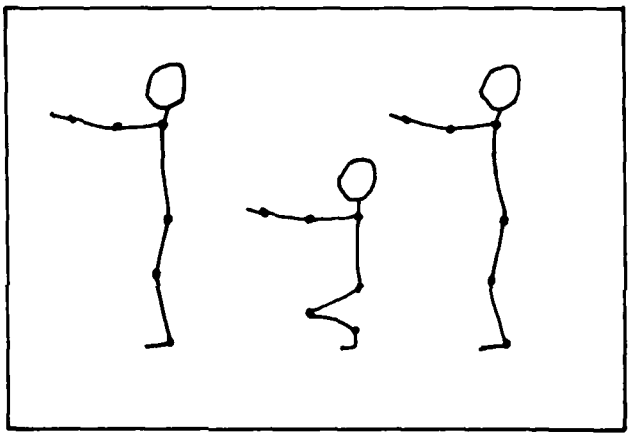
TEST NAME:
Deep Knee Bends

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Leg/Hip - Dynamic Strength - Extension.

EQUIPMENT NEEDED:
Stopwatch.

PROCEDURE:
Starting in an upright position, at the signal the subject goes to a full squat position (trying to touch heels) and then returns to the upright position. This maneuver is repeated as many times as possible in 30 seconds. The subject should be advised to keep the eyes on a fixed point and is allowed to extend arms to maintain balance.



SCORING:
Score = Number of bends completed in 30 seconds.

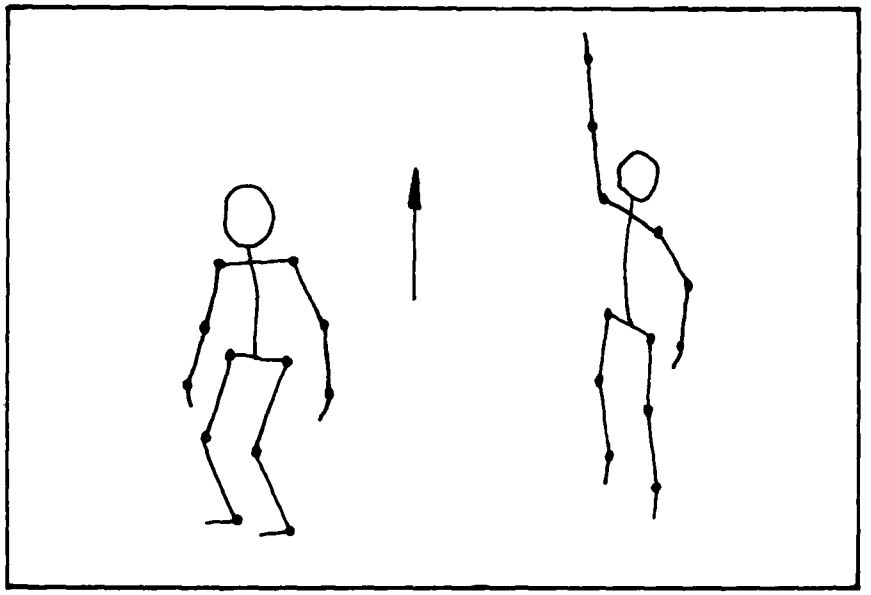
TEST NAME:
Vertical Jump

SOURCE:
Larson, 1940

FUNCTION(S) MEASURED:
Leg/Hip - Dynamic Strength (Explosive) - Extension.

EQUIPMENT NEEDED:
Measured jump heights on blackened board.

PROCEDURE:
With chalked fingers, the subject reaches as high as possible while standing and makes a mark on the board. The subject then crouches and jumps as high as possible making a mark on the board. This is repeated for a total of three jumps.



SCORING:
Score = The distance from the top of the reach mark to the top of the highest jump mark is measured to the nearest 1/4 inch and used as the score.

COMMENTS:
This is part of the Indiana Motor Fitness Test and is used for males. The value is combined with other scores to get the Indiana Motor Fitness Index.

TEST VARIATIONS:
Fleishman, 1964.

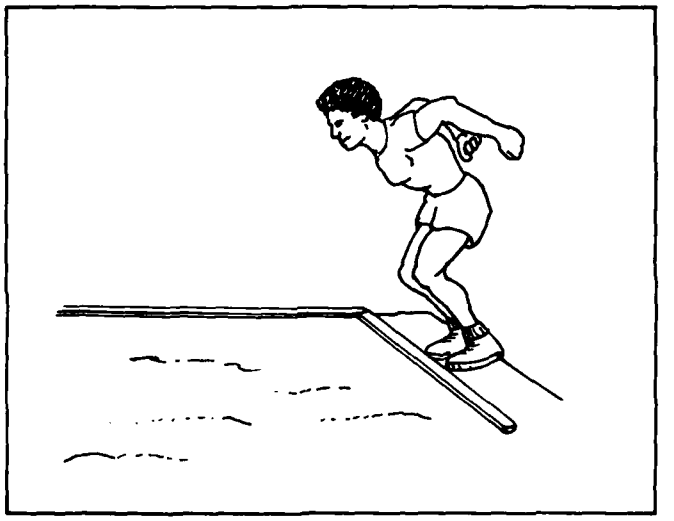
TEST NAME:
Standing Broad Jump

SOURCE:
Larson, 1974

FUNCTION(S) MEASURED:
Leg/Hip - Dynamic Strength (Explosive) - Extension.

EQUIPMENT NEEDED:
Flat, non-slip surface with take off line, tape measure, large T-square.

PROCEDURE:
The subject stands with toes just behind the take off line and jumps when ready. After making a preparatory backward swing with both arms, the subject swings them vigorously forward while springing from both feet simultaneously. The subject is given 2 trials.



SCORING:
Score = The distance jumped in the best of the two trials.

TEST VARIATIONS:
Mathews, 1973; Fleishman, 1964.

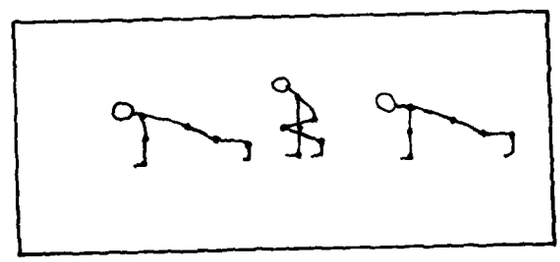
TEST NAME:
Squat Thrust

SOURCE:
Johnson and Nelson, 1969

FUNCTION(S) MEASURED:
Leg/Hip - Dynamic Strength - Flexion/Extension.

EQUIPMENT NEEDED:
Stopwatch, floor mat.

PROCEDURE:
The subject starts in a "push-up" position with arms outstretched, hands on floor just forward of shoulders, and legs outstretched. At the signal, the subject jumps the legs up under the body to a position where the heels are touching the buttocks and then returns the legs to a fully extended position. This maneuver is repeated as many times as possible in 30 seconds.



SCORING:
Score = Number of times the subject returns to the start position.

COMMENTS:
This test has been said to cause knee damage. Clarke, 1967, notes that it has been recommended by the American Medical Association Committee on Medical Aspects of Sports to be discontinued from use.

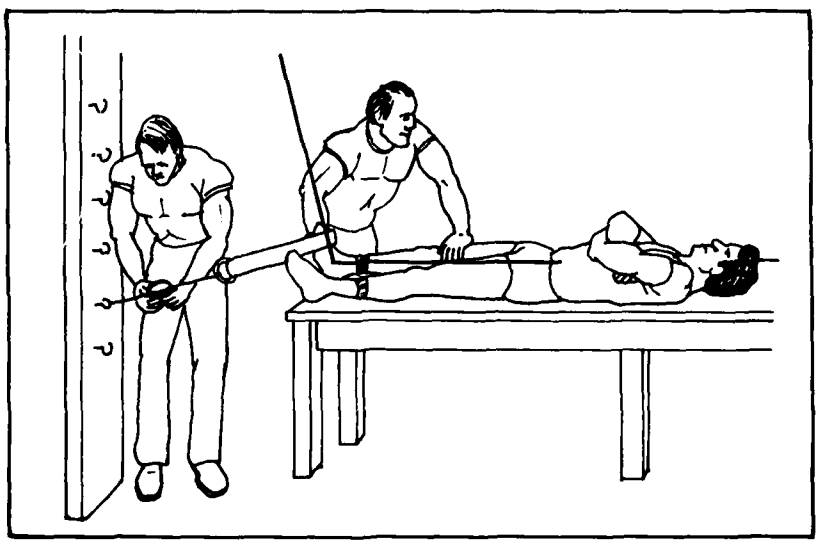
TEST NAME:
Ankle Dorsi Flexion

SOURCE:
Clarke, 1966

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Flexion.

EQUIPMENT NEEDED:
Dynamometer, load cell, tensiometer; goniometer; testing table.

PROCEDURE:
The subject is supine on the test table with legs extended at the hip and knee to 180° and the arms folded on the chest. The tested foot is at a 90° angle with the ankle. The strap to the measuring instrument is across the top of the foot and the subject attempts to dorsi flex the ankle.



SCORING:
Score = Pounds of force exerted.

TEST VARIATIONS:
Clarke, 1966.

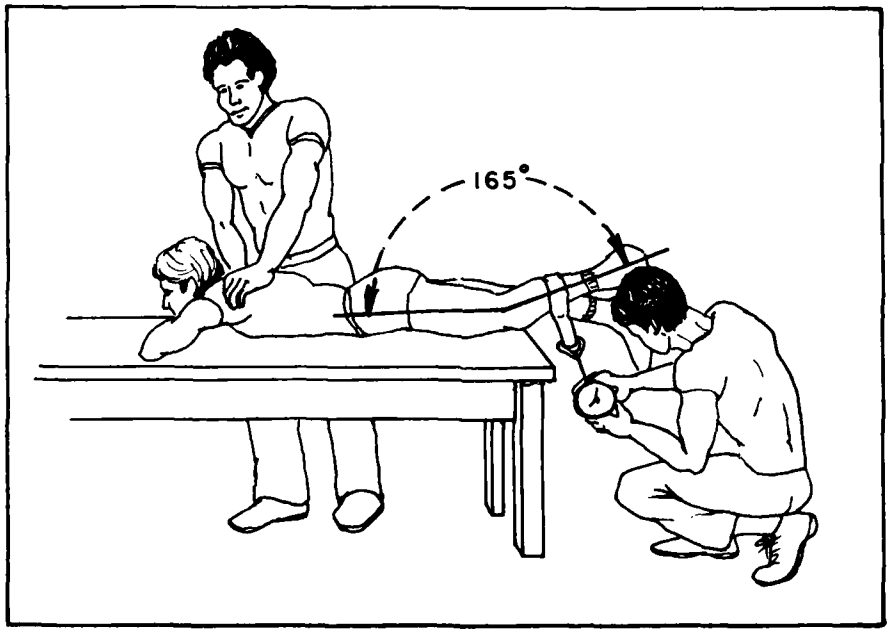
TEST NAME:
Knee Flexion

SOURCE:
Clarke, 1966

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Flexion

EQUIPMENT NEEDED:
Dynamometer, load cell or tensiometer; goniometer; testing table.

PROCEDURE:
The subject is prone on the test table with legs extended beyond the edge of the table so that the knee is resting on the edge. The arms are folded above the subject's head. The strap to the testing instrument is looped around the calf of the leg and the subject attempts to flex the knee.



SCORING:
Score = Pounds of force exerted.

COMMENTS:
There is no significant effect of natural hip raising on the knee flexor muscle measurement. This means that the hips do not need to be held down in the testing period.

TEST VARIATIONS:
Clarke, 1966.

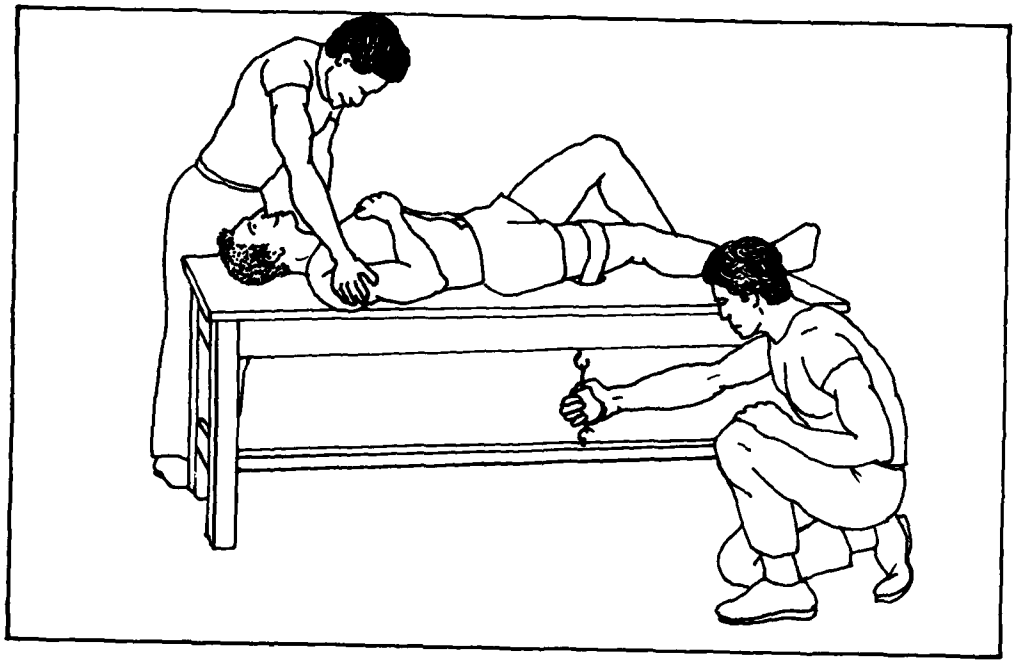
TEST NAME:
Hip Flexion

SOURCE:
Clarke and Clarke, 1963

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Flexion

EQUIPMENT NEEDED:
Dynamometer, load cell or tensiometer; goniometer; testing table.

PROCEDURE:
The subject is supine on the table with the free leg flexed, the test leg extended, and the arms across the chest. A strap is looped over the test leg just above the knee and extended through a hole in the table to the strength measuring equipment. The subject attempts to flex the leg at the hip.



SCORING:
Score = Pounds of force exerted.

TEST VARIATIONS:
Clarke, 1966.

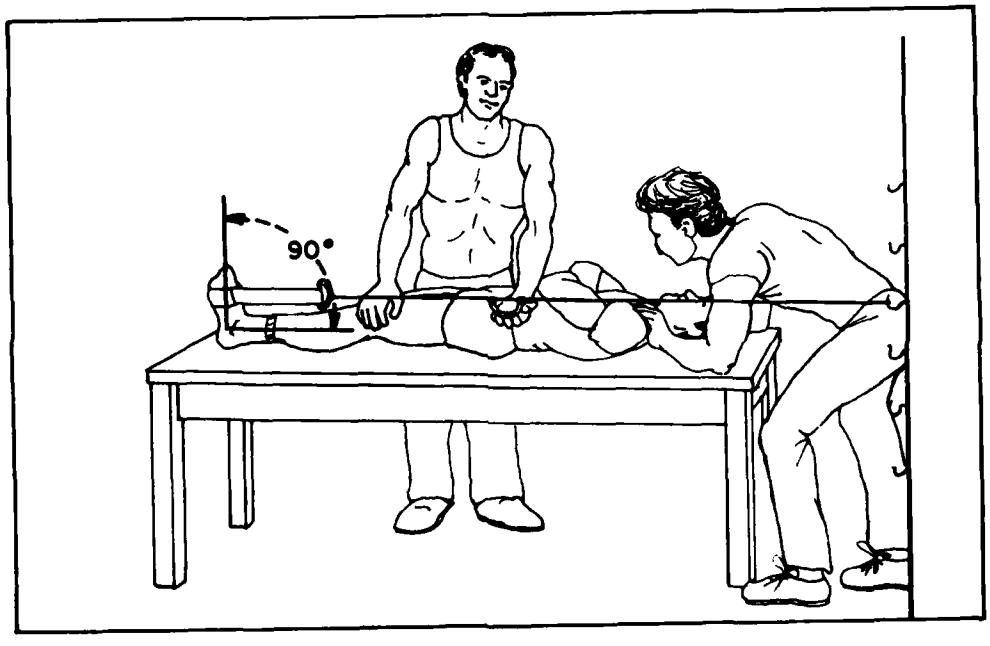
TEST NAME:
Ankle Plantar Extension

SOURCE:
Clarke, 1967

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Extension.

EQUIPMENT NEEDED:
Dynamometer, load cell or tensiometer; goniometer; testing table.

PROCEDURE:
The subject lies supine on the table with the legs extended at the hip and knee at 180° and the arms folded across the chest. The tested foot dorsi flexed at the ankle to 90°. With the strap across the ball of the foot, the subject attempts to plantar flex the foot.



SCORING:
Score = Pounds of force exerted.

COMMENTS:
Higher scores result from using shoulder brace blocks (instead of assistant) to prevent subject from sliding and a stirrup instead of a strap to keep the foot from being pinched.

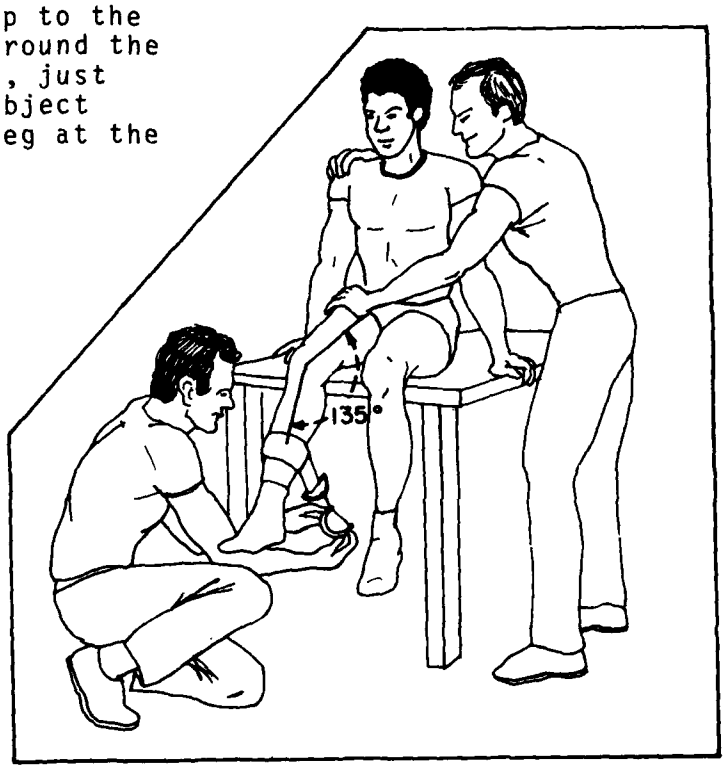
TEST NAME:
Knee Extension

SOURCE:
Clarke, 1967

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Extension.

EQUIPMENT NEEDED:
Dynamometer, load cell, or tensiometer; goniometer; testing table.

PROCEDURE:
The subject is seated at the end of the table with the legs hanging over the edge. He leans back using the arms to brace himself with the elbows locked. The free leg is allowed to hang; the tested leg is flexed at the knee 135°. The strap to the measuring apparatus is around the lower portion of the leg, just above the ankle. The subject attempts to extend the leg at the knee.



SCORING:
Score = Pounds of force exerted.

TEST VARIATIONS:
Clarke, 1966.

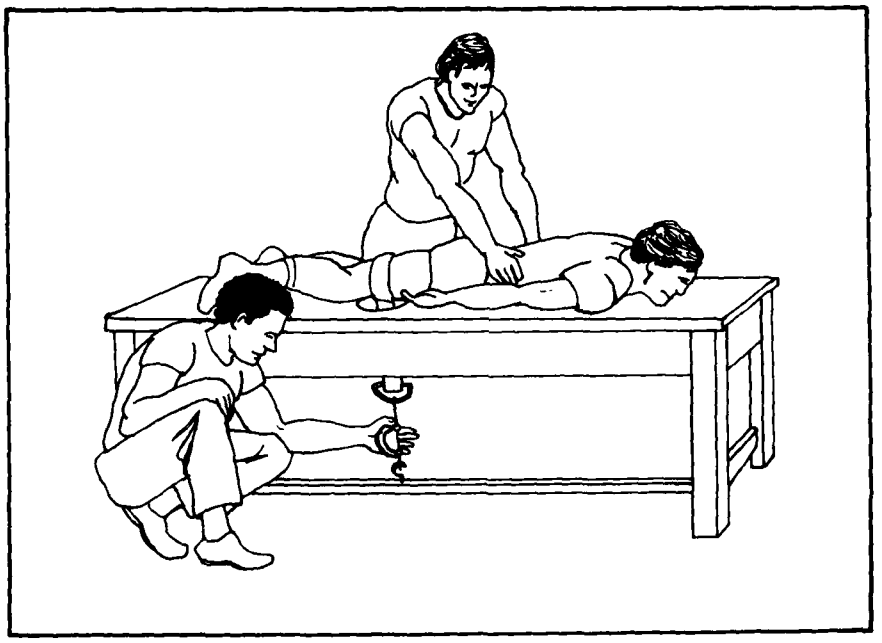
TEST NAME:
Hip Extension

SOURCE:
Clarke and Clarke, 1963

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Extension

EQUIPMENT NEEDED:
Dynamometer, load cell, or tensiometer; goniometer, testing table.

PROCEDURE:
The subject lies prone on the table with the arms at his side and free leg flexed at knee and foot flat on table. The tested leg is fastened to the measuring apparatus by a strap that goes around the thigh and through the hole in the table.



SCORING:
Score = Pounds of force exerted.

TEST VARIATIONS:
Clarke, 1966.

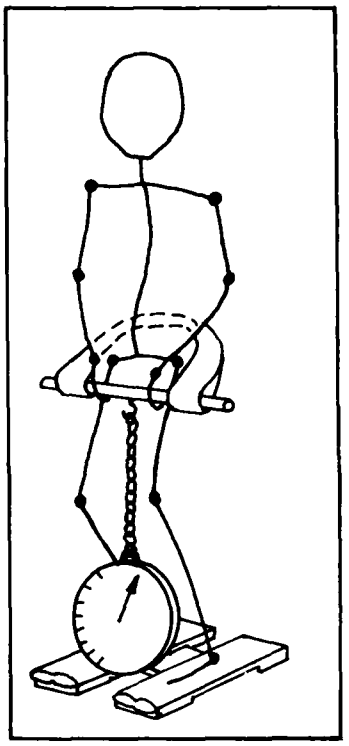
TEST NAME:
Leg Lift (Extension)

SOURCE:
Cureton, 1947

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Extension.

EQUIPMENT NEEDED:
Dynamometer on platform with chain and handle attached; belt to stabilize handle.

PROCEDURE:
The subject stands on the dynamometer platform with knees flexed to 115° - 125°. The subject grasps the center of the handle with palms down at the level of the pubic bone. The belt is looped from one end of the handle around the sacrum and to the other end of the handle to stabilize it. The subject attempts to straighten the legs while keeping the head up and the back straight. The handle will be against the subject thighs during the test.



SCORING:
Score = Number of pounds of force exerted.

COMMENTS:
This test is described as difficult to administer.

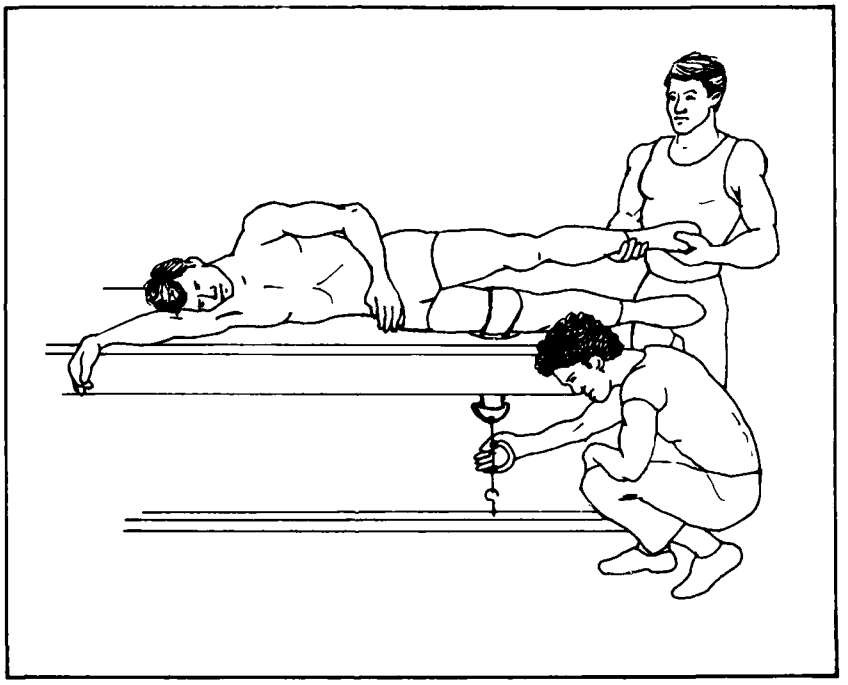
TEST NAME:
Hip Adduction

SOURCE:
Clarke et al., 1950

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Adduction

EQUIPMENT NEEDED:
Dynamometer, load cell, or tensiometer; goniometer, testing table.

PROCEDURE:
The subject lies on one side with lower arm extended under head and upper arm bent at elbow to rest hand on table in front of the waist. The strap to the dynamometer goes around the thigh of the lower leg and through the hole in the table. The subject attempts to adduct the leg.



SCORING:
The score is the pounds of force exerted.

COMMENTS:
Alternate procedures do not result in as high a strength measurement.

TEST VARIATIONS:
Clarke, 1966.

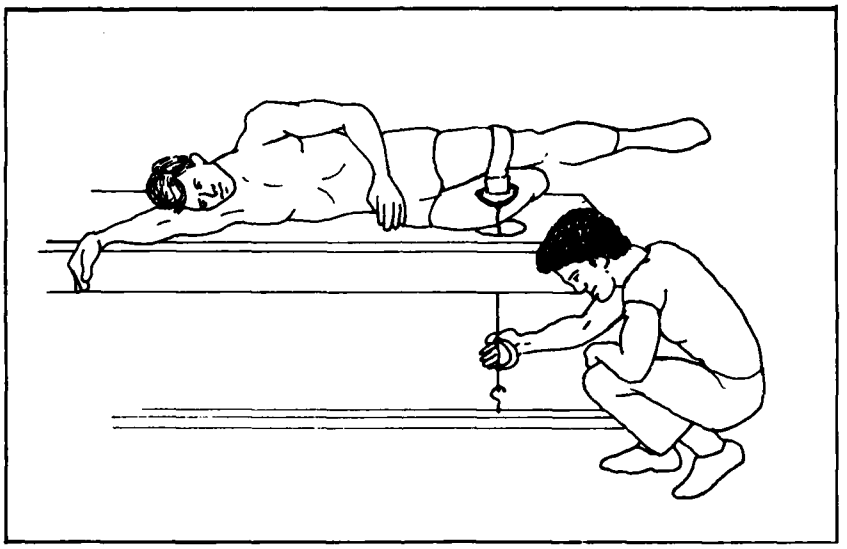
TEST NAME:
Hip Abduction

SOURCE:
Clarke et al., 1950

FUNCTION(S) MEASURED:
Leg/Hip - Static Strength - Abduction.

EQUIPMENT NEEDED:
Dynamometer, load cell, or tensiometer; goniometer; testing table.

PROCEDURE:
The subject lies on one side with lower arm extended under head and upper arm bent at elbow to rest hand on table in front of the waist. The lower leg is flexed to allow strap to extend through table and around thigh of upper leg. The subject attempts to abduct the leg.



SCORING:
The score is the pounds of force exerted.

COMMENTS:
Alternate procedures do not result in as high a strength measurement.

TEST VARIATIONS:
Clarke, 1966.

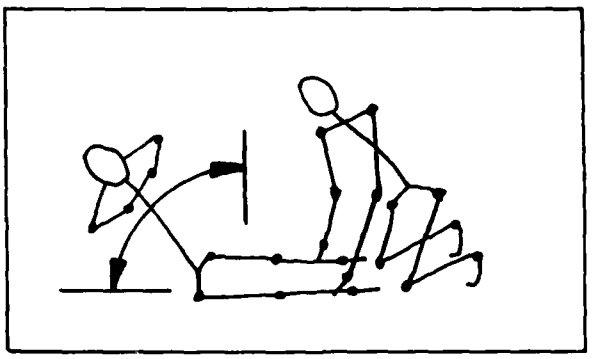
TEST NAME:
Sit-Ups

SOURCE:
Hunsicker and Reiff, 1976

FUNCTION(S) MEASURED:
Trunk - Dynamic Strength - Flexion

EQUIPMENT NEEDED:
Stopwatch, floor mat

PROCEDURE:
The subject lies supine on the floor mat with knees flexed at a right angle and with the feet approximately 30 cm apart. The hands with the fingers interlocked, are placed on the back of the neck. The feet are held down during the test by an assistant. At the signal, the subject sits up to touch knees with elbows and then returns to the start position. The subject does as many sit-ups as possible in 30 seconds.



SCORING:
Score = Number of sit-ups completed in 30 seconds.

TEST VARIATIONS:
Fleishman, 1964, Sharkey and Jakkula, 1977.

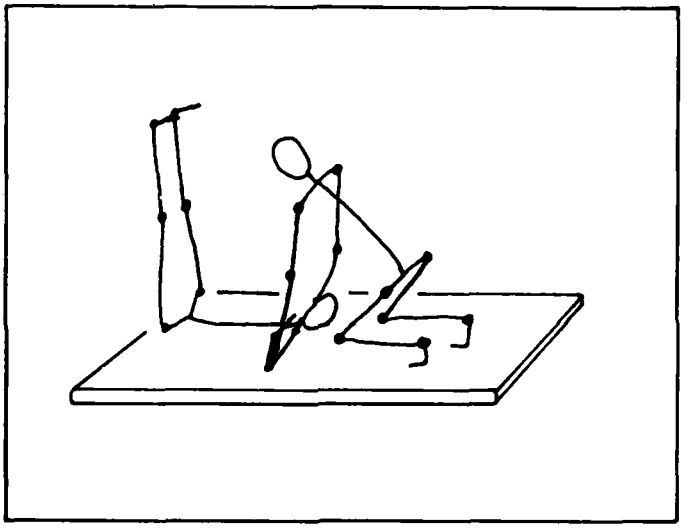
TEST NAME:
Leg Lifts

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Trunk - Dynamic Strength - Flexion.

EQUIPMENT NEEDED:
Stopwatch, floor mat.

PROCEDURE:
The subject lies supine with hands behind neck, the elbows are held down by an assistant. At the signal, the subject raises his legs to a nearly vertical position and then returns them to the floor as many times as possible in 30 seconds. The subject is to keep the small of the back and spine on the floor during the test.



SCORING:
Score = Number of times the legs are lifted to the vertical position.

TEST VARIATIONS:
Fleishman, 1964.

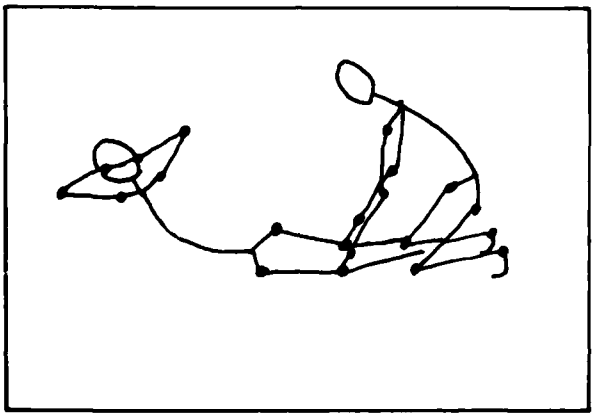
TEST NAME:
Back Lift (Reverse Sit-Up)

SOURCE:
Sharkey and Jakkula, 1977.

FUNCTION(S) MEASURED:
Trunk - Dynamic Strength - Extension.

EQUIPMENT NEEDED:
Floor mat.

PROCEDURE:
The subject lies prone on the floor mat with hands behind the neck while an assistant holds the legs to the floor. At the signal, the subject raises the upper body, arching the back to a height of at least 9 inches. The subject repeats this procedure for up to 10 repetitions.



SCORING:
Score = Number of successful repetitions.

COMMENTS:
This test has been discontinued for use in the Forest Service Test Battery due to the possibility of back injury.

TEST VARIATIONS:
Fleishman, 1964

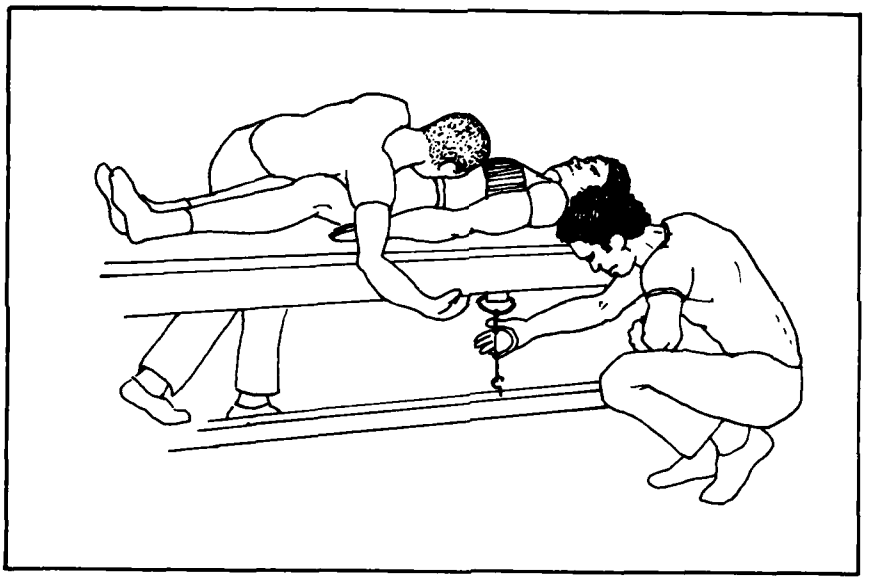
TEST NAME:
Trunk Flexion

SOURCE:
Clarke, Bailey and Shay, 1952

FUNCTION(S) MEASURED:
Trunk - Static Strength - Flexion.

EQUIPMENT NEEDED:
Dynamometer, load cell, or tensiometer; goniometer; testing table.

PROCEDURE:
The subject lies on the test table in a supine position with hip and knee joints straight. Strap to the measuring apparatus goes around the subject's chest and through the hole in the table. An assistant holds the subject's legs down while the subject attempts to "sit up."



SCORING:
Score = Pounds of force exerted.

TEST VARIATIONS:
Clarke, 1966; Fleishman, 1964.

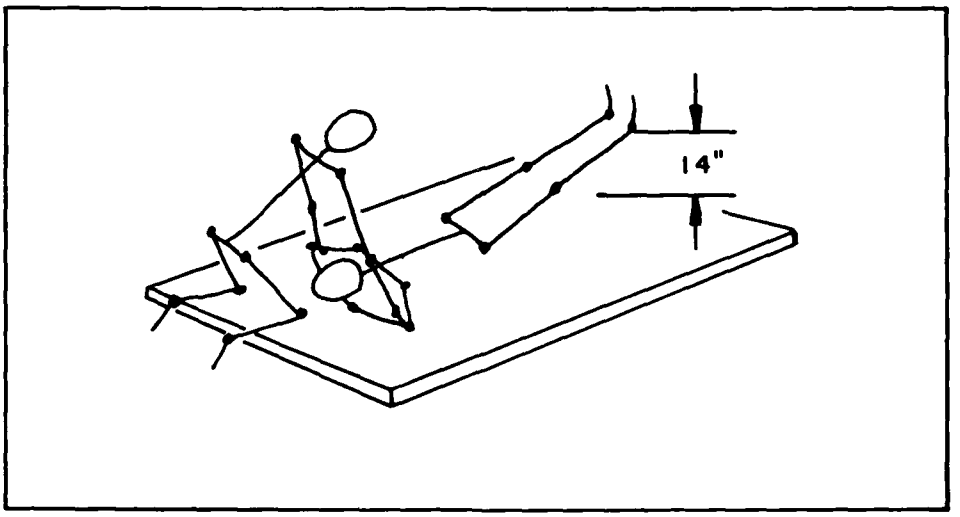
TEST NAME:
Leg Raiser

SOURCE:
McHone et al, 1952

FUNCTION(S) MEASURED:
Trunk - Static Strength - Flexion.

EQUIPMENT NEEDED:
Floor mat, stopwatch.

PROCEDURE:
The subject lies supine on the mat with hands clasped behind the neck and the elbows held down by an assistant. At the signal, the subject lifts both legs 14 - 16 inches off the floor and holds them in this position. The legs are kept straight in this position as long as possible. The tester holds a pencil under the legs to make sure the subject does not drop below approximately 14 inches. The examiners may exhort the subject to continue holding the legs as long as possible.



SCORING:
Score = Number of seconds the legs are kept in the air.

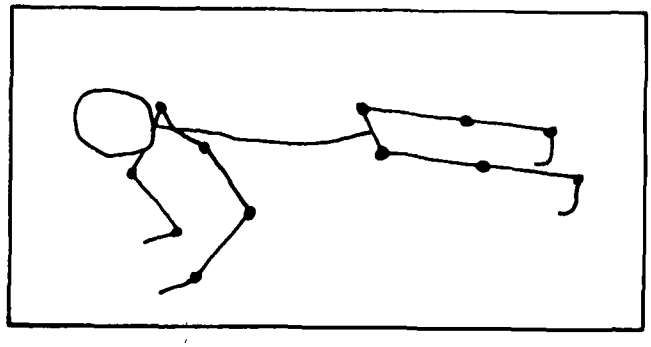
TEST NAME:
Hold Half-Sit Up

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Trunk - Static Strength - Flexion.

EQUIPMENT NEEDED:
Floor mat, stopwatch.

PROCEDURE:
The subject lies supine on the floor mat with knees held down by an assistant. The subject "sits-up" until the body is at a 40° angle with the floor. The hands are to be behind but not touching the neck and the chest should be out. The subject holds this position for as long as possible.



SCORING:
Score = Number of seconds the proper position was held.

COMMENTS:
It would appear possible to strain the abdominal muscles with this test.

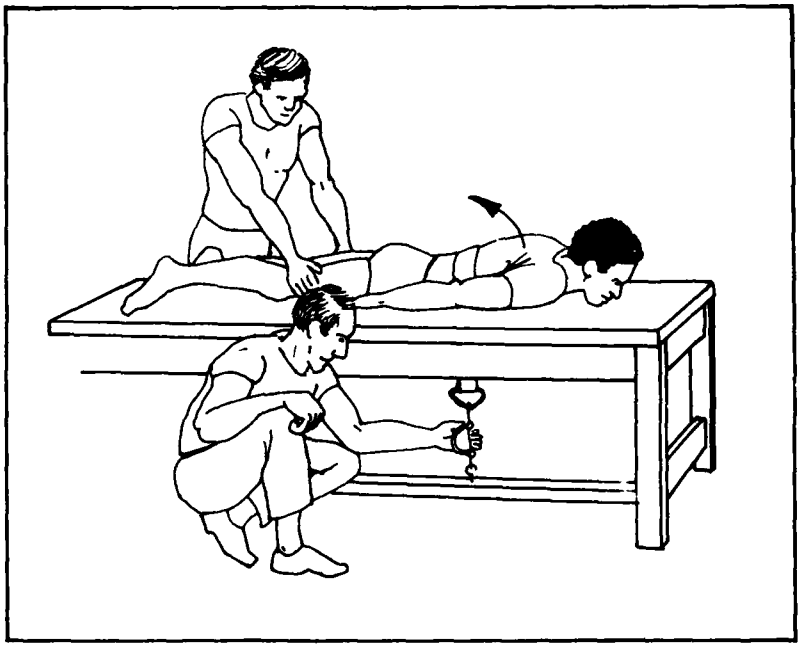
TEST NAME:
Trunk Extension

SOURCE:
Clarke, Bailey and Shay, 1952

FUNCTION(S) MEASURED:
Trunk - Static Strength - Extension.

EQUIPMENT NEEDED:
Dynamometer load cell, or tensiometer; goniometer; testing table.

PROCEDURE:
The subject lies prone on the test table with arms to the side. The strap from the measuring device passes around the chest and through the hole in the table. The legs are held down by an assistant while the subject attempts to arch the back.



SCORING:
Score = Pounds of force exerted.

TEST VARIATIONS:
Clarke, 1966; Kamon and Goldfuss, 1977.

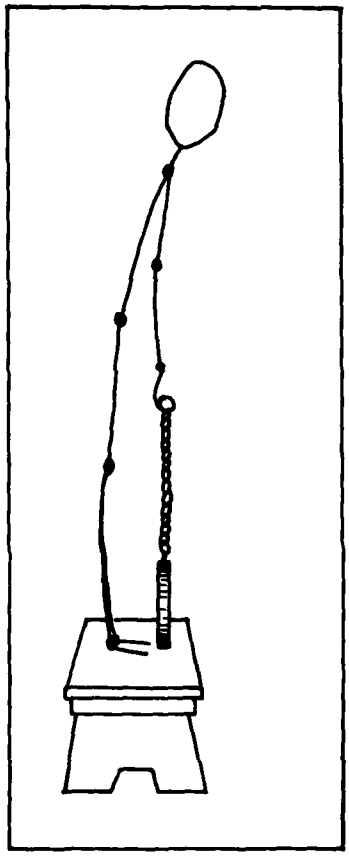
TEST NAME:
Back Lift

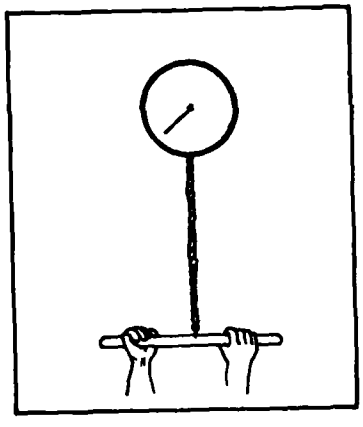
SOURCE:
Cureton, 1947

FUNCTION(S) MEASURED:
Trunk - Static Strength - Extension.

EQUIPMENT NEEDED:
Dynamometer attached to base with handle and chain.

PROCEDURE:
The subject stands on the dynamometer base with feet parallel and 6 inches apart. The head is erect and the back straight. With the hands in front of the thighs, the bar is adjusted to the height of the fingertips. The subject then leans forward to grasp the bar with a mixed grip and attempts to straighten the body. The legs and arms are kept straight throughout the test.





SCORING:
Score = Amount of pounds of force exerted.

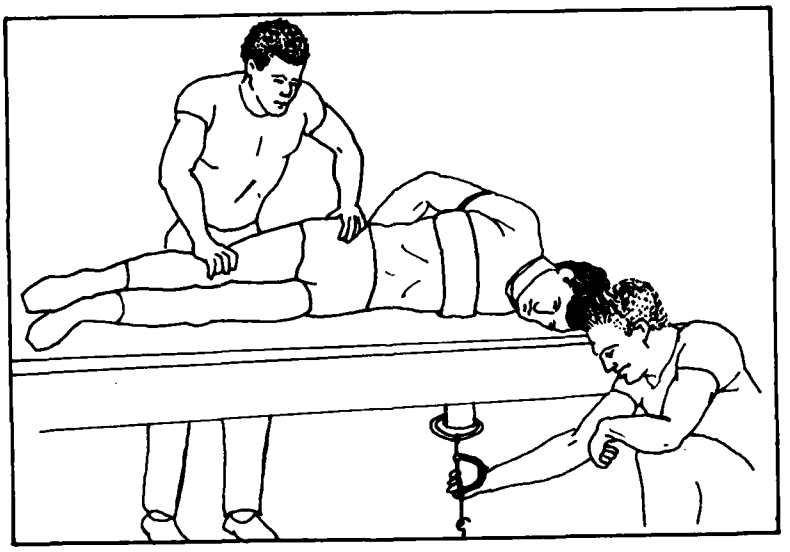
TEST NAME:
Trunk Lateral Flexion

SOURCE:
Clarke, Bailey and Shay, 1952

FUNCTION(S) MEASURED:
Trunk - Static Strength - Lateral Flexion.

EQUIPMENT NEEDED:
Dynamometer, load cell, or tensiometer; testing table.

PROCEDURE:
The subject lies on the table on one side with legs together and extended. The upper arm is at the side and the lower arm extends through a slit in the table. The strap to the measuring apparatus passes around the chest and through a hole in the table. As the hips and legs are steadied by an assistant, the subject attempts to laterally flex the body.



SCORING:
Score = Pounds of force exerted.

TEST NAME:
Foster's Test

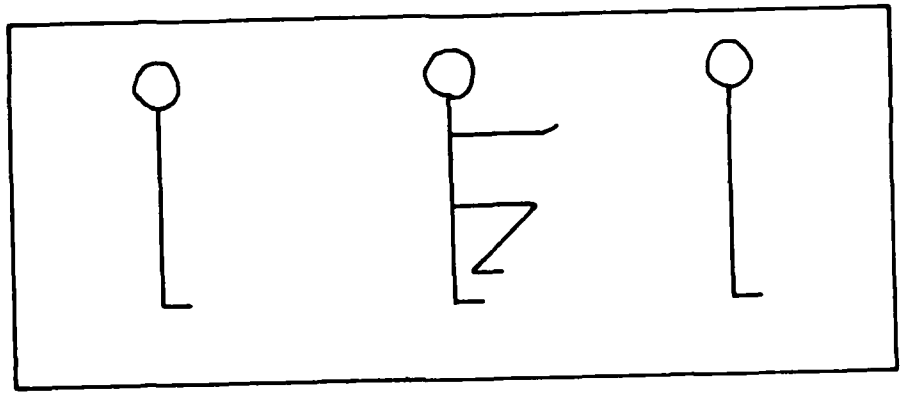
SOURCE:
Foster, 1914

FUNCTION(S) MEASURED:
Cardio-Vascular Fitness.

EQUIPMENT NEEDED:
Pulse meter or individual skilled in pulse measurements, stopwatch.

PROCEDURE:
The subject's normal standing pulse rate is first obtained. The subject then runs in place for 15 seconds at the rate of 180 steps per minute. Immediately following cessation of activity, the pulse rate is taken for 5 seconds. This value is then multipled by 12. After 45 seconds of standing at ease, the pulse rate is again taken and recorded. An efficiency rating is calculated using these three pulse rates according to the following formula:

Efficiency rating = Standing pulse rate + (First rest pulse - Standing rate) + (45 second rest pulse - Standing pulse).



SCORING:
Score = Efficiency rating. The maximum attainable score is 15.

COMMENTS:
The subject in good condition should not show an increase in heart rate of more than 40 beats per minute.

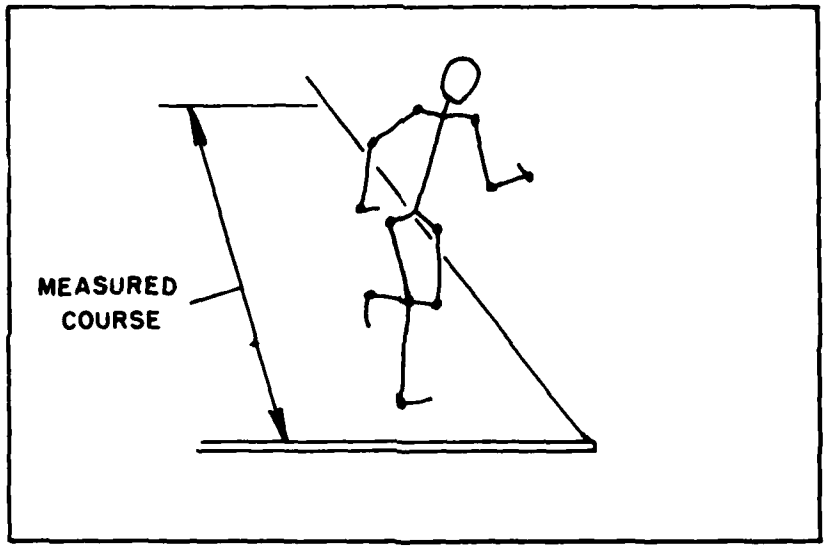
TEST NAME:
Running Tests - Sprints

SOURCE:
See test variations below.

FUNCTION(S) MEASURED:
Cardio-vascular fitness.

EQUIPMENT NEEDED:
Stopwatch, measured running course.

PROCEDURE:
The subject starts with one knee on the ground and fingers at the start line. At the command "get start," the subject raises the body off the haunches and at the command "go," runs the measured distance as fast as possible. The subject is allowed 2 trials at the 10 yard distance, but only one trial at the longer distances.



SCORING:
Score = The time to the tenth of a second required to run the measured distance.

COMMENTS:
The subjects start from a standing position for the 50 meter sprint as opposed to the crouch start.

TEST VARIATIONS:
10 yard, 50 yard dash - Fleishman, 1964; 50 meter sprint, Larson, 1974.

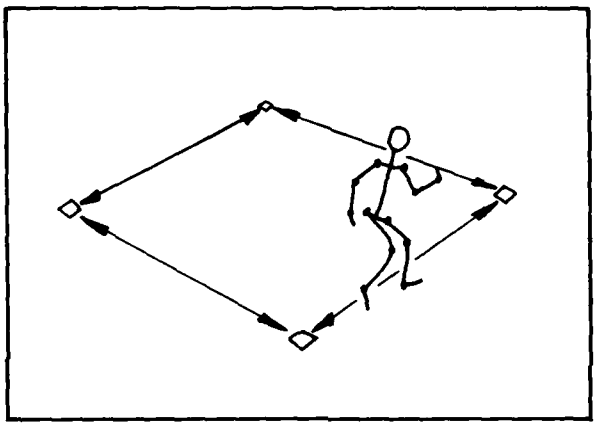
TEST NAME:
Running Test - Distance

SOURCE:
See test variations below.

FUNCTION(S) MEASURED:
Cardio-vascular fitness.

EQUIPMENT NEEDED:
Stopwatch, measured track.

PROCEDURE:
The subject is started from a standing position behind the starting line. At the signal, he attempts to cover the course as quickly as possible. The subject may intersperse walking with running as necessary however. If there are individual spotters, several runners may be started at the same time.



SCORING:
Score = Time required to cover the measured distance.

COMMENTS:
If more than one individual is running, they need to be either started at separate times, or the track should be divided into lanes.

TEST VARIATIONS:
600 yard run/walk - Fleishman, 1964b, 1 1/2 mile run - Sharkey and Jakkula, 1977; Balke 15 minute run, Cooper 12 minute run, Shepard 1-2 mile run - Larson, 1974.

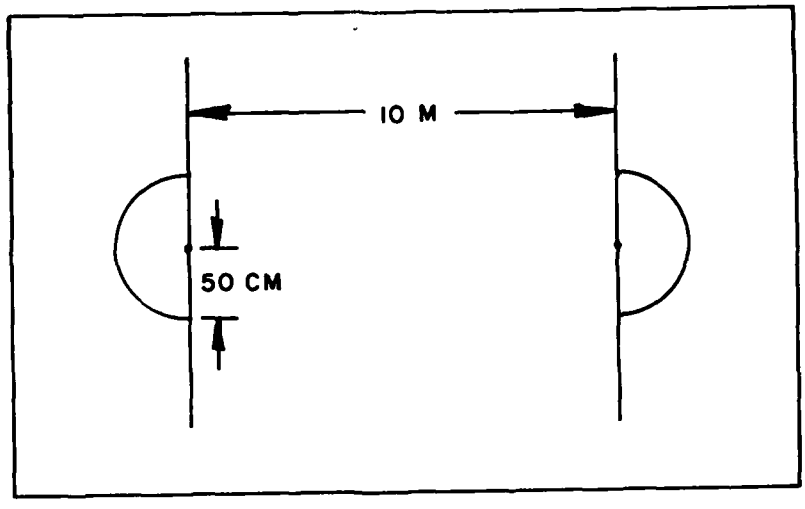
TEST NAME:
Shuttle Run

SOURCE:
Larson, 1974

FUNCTION(S) MEASURED:
Cardio-vascular fitness and gross motor skill.

EQUIPMENT NEEDED:
Stopwatch, 10 meter flat course with 2 parallel base lines, 2-50 cm radius semi-circles behind baseline, 2 wooden blocks (5x5x5 cm).

PROCEDURE:
The subject stands with the front foot behind the starting line. At the start signal, the subject runs to the semi-circle 10 meters away and picks up the wooden block. The subject then runs back to semi-circle at the start line and places the block in it. The block cannot be thrown into the circle. Without pausing, the subject repeats the dash for the second block and returns it to the starting line semi-circle.



SCORING:
Score = Time to the nearest tenth second for the second block to be returned to the semi-circle.

TEST VARIATIONS:
Fleishman, 1964.

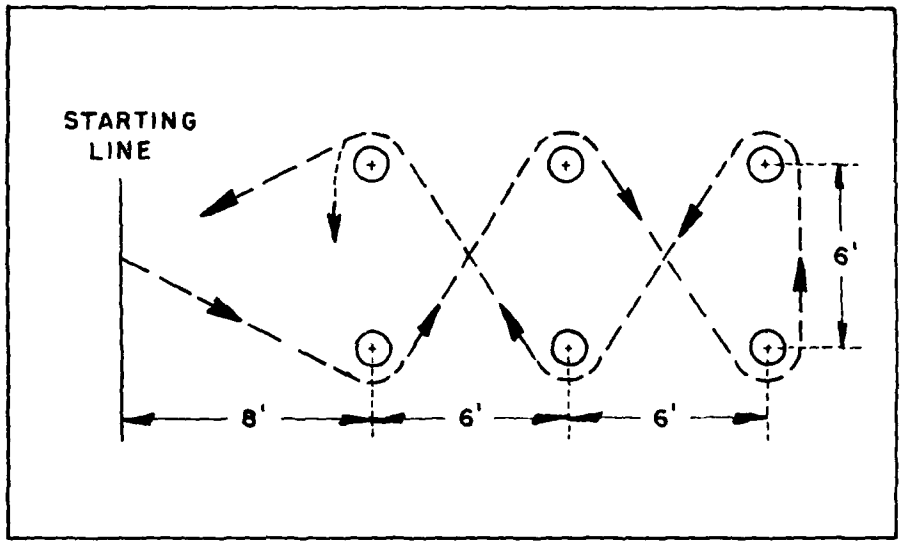
TEST NAME:
Dodge Run

SOURCE:
Fleishman, 1964

FUNCTION(S) MEASURED:
Cardio-vascular fitness.

EQUIPMENT NEEDED:
Stopwatch, 6 obstacles, room for 6 foot x 20 foot course.

PROCEDURE:
The subject starts at the middle of the starting line and runs in a path around the obstacles. After going through the course twice, the subject runs back to the starting line.



SCORING:
Score = Number of seconds to make two trips around the obstacles and return to the starting line.

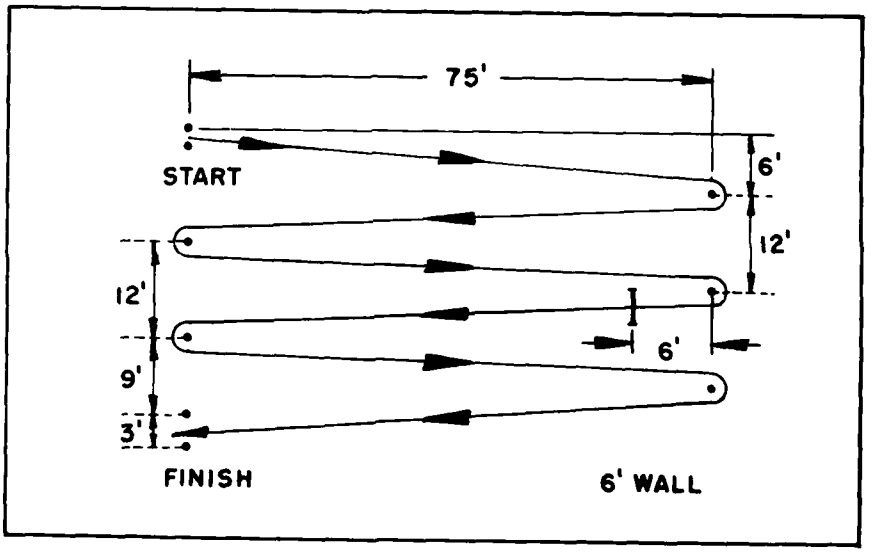
TEST NAME:
Wall surmount/Shuttle Run

SOURCE:
Doolittle, 1975

FUNCTION(S) MEASURED:
Cardio-vascular fitness and arm/leg strength.

EQUIPMENT NEEDED:
Six foot "wall," pylons, space for 75 foot x 36 foot course.

PROCEDURE:
The subject must run over a course with six, 75 foot legs. The first three legs of the course are flat running. On the fourth leg, the subject must climb over a six foot high wall that is placed six feet from the start of the leg. After climbing the wall, the subject has to finish that leg plus two more 75 foot legs for a total of 150 yards.



SCORING:
Score = Time to run the course in seconds. However, the score is 0 if the wall is not surmounted.

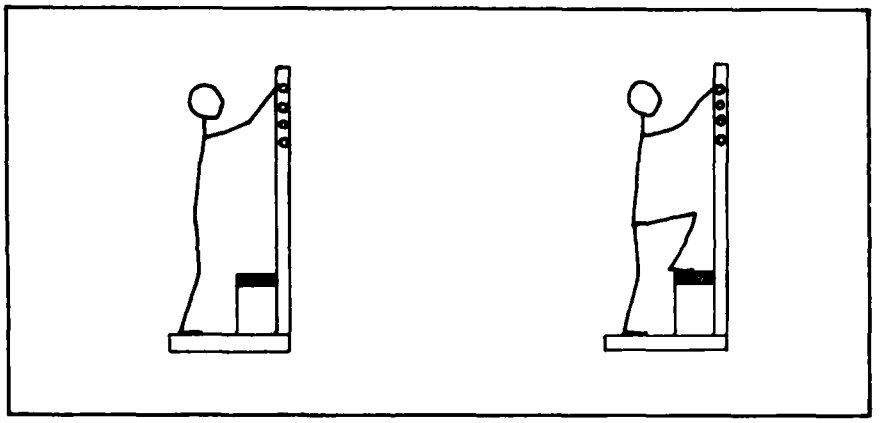
TEST NAME:
Stepping Tests

SOURCE:
See test variations below.

FUNCTION(S) MEASURED:
Cardio-vascular fitness

EQUIPMENT NEEDED:
Stopwatch, stepping bench of appropriate height, pulse meter, metronome.

PROCEDURE:
In a stepping test, the subject steps onto and off of a bench at a prescribed rate. The length of time for the exercise depends upon the type of test being administered. A sub-maximal test is stopped after a set length of time is reached or a prescribed heart rate is reached. The maximal test is stopped only after a longer time period has been completed (which most people cannot meet) or when the subject can no longer step at the prescribed rate. The duration in time of the exercise is recorded. During recovery, the pulse rate is measured at prescribed times.



SCORING:
Score is based upon recovery heart rate and the duration of the test in seconds.

COMMENTS:
The Tuttle pulse-ratio test and the Ohio State University Step Test are both tests that have intermittent stepping and rest periods.

TEST VARIATIONS:
Tuttle Pulse - Ratio Test, Ohio State University Step Test, Harvard Step Test, Sloan Step Test - Mathews, 1973; Ergometer Step Test - Larson, 1974; Firefighters Step Test - Sharkey and Jakkula.

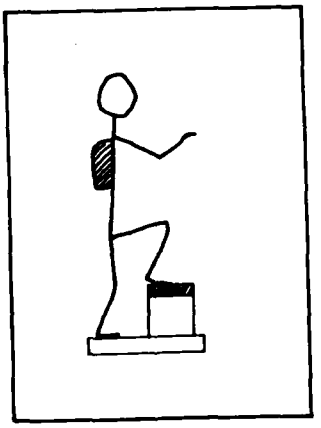
TEST NAME:
Pack Test

SOURCE:
Taylor and Craig, 1944

FUNCTION(S) MEASURED:
Physical Work Capacity.

EQUIPMENT NEEDED:
18 inch bench with crossbar, backpack, 10 lb. weights to fit in pack, stopwatch, pulse meter.

PROCEDURE:
The subject starts by placing the left foot on the bench and grasping the crossbar with their left hand. At the command "go," the subject comes to a vertical position on the bench. He then steps back off of the bench and continues the movement with the left foot at a rate of 40 steps per minute. Every 30 seconds the subject changes the lead leg without breaking rhythm. The subject starts the test with a 10 lb. weight in the back pack. Every 2 minutes, an additional 10 lb. weight is added. The subject continues stepping until the cadence can no longer be maintained. The pulse rate is checked 10-30 seconds post-exercise.



SCORING:
Score = Total exercise time period.

COMMENTS:
This is a very demanding maximal stress test. Appropriate test precautions should be made.

TEST VARIATIONS:
Sharkey and Jakkula, 1977.

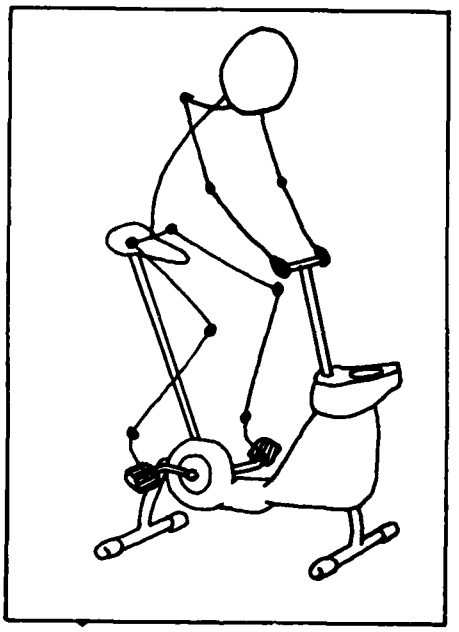
TEST NAME:
Bicycle Ergometer Tests

SOURCE:
See test variations below.

FUNCTION(S) MEASURED:
Cardio-vascular fitness.

EQUIPMENT NEEDED:
Bicycle Ergometer, metronome, clinical scales, oxygen analyzer.

PROCEDURE:
In bicycle ergometer tests the subject peddles at a set revolutions per minute. The work load may be constant or incrementally increased. Sub-maximal tests are stopped after a given time period or when a prescribed heart rate is reached. Maximal tests continue until the subject can no longer maintain the pace.



SCORING:
Score is based either on the amount of oxygen consumed or the work intensity and duration.

COMMENTS:
This can be a very physical demanding test. Appropriate precautions should be made.

TEST VARIATIONS:
Larson, 1974; Astrand and Rodahl, 1970.

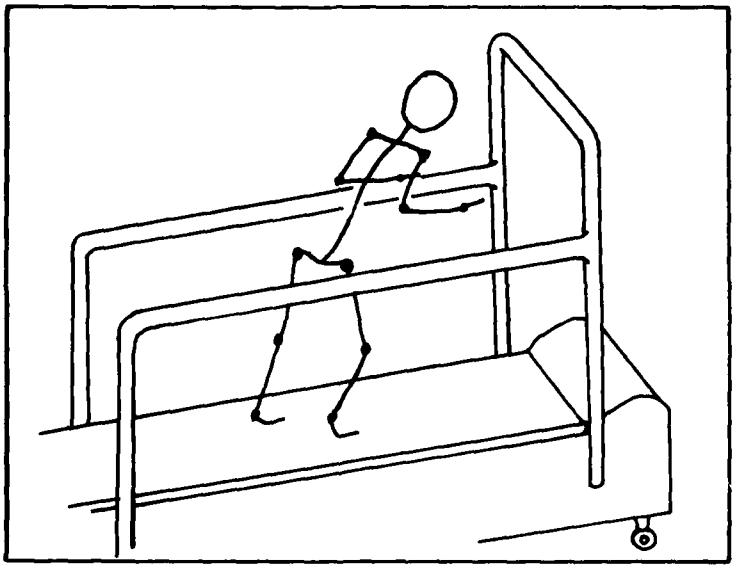
TEST NAME:
Treadmill Tests

SOURCE:
See test variations below.

FUNCTION(S) MEASURED:
Cardio-vascular fitness.

EQUIPMENT NEEDED:
Treadmill with variable speed and grade, stopwatch, heart monitor, oxygen analyzer.

PROCEDURE:
The subject walks at a prescribed speed and grade on the treadmill. The work load is increased by increasing the speed and/or the grade. For sub-maximal tests, the subject is worked until a prescribed heart rate is reached. In maximal tests, the subject runs either until exhaustion or until a maximal heart rate is reached. Heart monitoring is continued during recovery for at least the first three minutes.



SCORING:
Score is based on oxygen consumption or calculations using the heart rate and test duration.

COMMENTS:
Maximal tests are very strenuous. Appropriate safety precautions must be made.

TEST VARIATIONS:
Balke, Billings, and the Johnson, Brouha, and Darling Treadmill Tests - Mathews, 1973; Ergometer Treadmill Test - Larson, 1974; Astrand and Rodhal, 1970.

APPENDIX 5

INFORMATION FLOW ANALYSIS

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
Phase I. Analysis of Air Force Specialty Codes (AFSCs) to Quantify Tasks Requiring Significant Physical Demands 1.1 Assembly of Existing AFSCs' Task Lists			
Tasks that are performed in each AFSC	The data will be obtained from OMRD/HRL job description surveys; AFSC job descriptions AFM 39-1; ATC training manuals; Specialty Training Standards (STS) including the relevant study references and operational and maintenance manuals. The data will be narrative listings consisting of the titles of the various tasks performed under each AFSC.	The tasks will be compiled in lists specific to each AFSC such that they will be used in an incumbent survey questionnaire for the purpose of subjectively identifying those tasks requiring significant demands (steps 1.2 and 1.3). The task lists will also permit the identification of the types of equipment which will be needed for the task analyses in step 1.5. Hence, the contractor will be able to define, perform a hazard analyses on and procure the equipment (step III.A) needed for task measurement (step 1.5) with sufficient lead time to avoid delays.	Administration of a mini-survey (Appendix 1) and a review of existing Air Force documentation regarding the task makeup of an AFSC indicates that the compiled task lists are accurate for the purposes of the initial screening of demands. If desired by the contractor or the Air Force, provision may be made in the design of the survey (1.2, Table 2, page 27) to permit incumbents to add to the list additional tasks being performed or to indicate which tasks are no longer performed for the particular AFSC.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
I.2 Development and Administration of Survey Questionnaire to Identify AFSC Tasks Requiring Significant Physical Demands A machine scoreable survey questionnaire will be developed using the following information: (1) Operational Definition of Task Physical Demands (Table 1, page 24). (2) Table 2. Establishment of Range and Distribution of Physical Demands of AFSCs.	The literature contains a number of definitions of physical demands. The basis for each is anticipated to vary from subjective observations to objective measures. The definition will be principally in narrative form to include quantitative values in units of kilograms, meters, and frequency of occurence per day.	The data will be used by the contractor to develop an operational definition of task physical demands applicable to Air Force jobs. The operational definitions will be used in a survey questionnaire to be administered to a sample of incumbents. The incumbents will rate each task according to the operational scale to show its level of demand.	The definitions developed as a result of I.2 efforts will be based on research and publications of recognized experts. Validation is assumed to have been accomplished by those individuals. Because these definitions will be used for an initial screening and categorization of the tasks, additional validations would not be necessary in this step.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNIT	DESCRIPTION OF DATA USE	VALIDATION OF DATA
(a) Task Lists. A list of tasks unique to each AFSC.	The task listings will be developed in step 1.1. They will be in a narrative listing form to provide a task title list for each AFSC.	The task title listings will be entered on each AFSC survey such that incumbents can evaluate each task as to the percent of time spent performing the task and the level of physical demand of each task if the incumbent performs the task.	The listings obtained from Air Force documents and OMRD/HRL surveys will be assumed valid for this purpose.
(b) Do you perform this task?	The data will be a yes or no, indicated by a check in the appropriate column opposite the task title. No units of measure will be used.	The data will be used to serve as an indicator to the incumbent that no further action is necessary for this task if the incumbent does not perform this task. If the incumbent does perform the task then the subsequent questions must be answered. It also serves as an indicator to the contractor whether or not the incumbent is aware of the particular task in the list and whether or not any further response is required. This data will also provide the percent of incumbents performing each task. This will be used in step 1.6.	It is anticipated that a small percentage of the answers may be in error. However, the answers given can be checked against whether or not the incumbent listed a percent time spent and/or if the task was rated as to its physical demands. If the answer was "no" then no subsequent action should occur. If the answer was "yes" then entries should be made in both subsequent columns.
(c) What percent of your time is spent on this task? This data is currently available from OMRD/HRL surveys for approximately 300 AFSCs.	The data will be subjective estimates which have been documented by the Air Force and is readily available. The data will be a quantitative value in percent time spent on the specific task.	The data will be used to compute the function 'G' as discussed and used in section I.6. The value of 'G' will be a function of the percent of individuals performing the task and the percent of time those individuals spend performing the task. This will be used	An objective validation will be performed using the statistical methods outlined in Appendix 2. The responses of incumbents within the same AFSC from the

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
This effort will not be duplicated. The data will be requested from incumbents performing in AFSCs for which the data is not readily accessible.		to develop a distribution from which the contractor will select tasks which are most representative of the demand of a particular AFSC as candidates for performance criteria tasks (PCTs).	same Air Force base will be used for this validation. It should be noted that further analysis on the tasks identified as significantly demanding will be performed by using interviews. Therefore, further validations will be performed at later steps (I.4, I.5, I.6).
(d) Levels of Physical Demands	The incumbents will identify the level of physical demand for each task they perform. The format will be a rating of the task according to the operational definitions. The rating will be one of the levels on the developed 5 or 9 point scale.	The data will be used to identify those tasks having significant physical demands.	An objective validation of the questionnaire responses will be accomplished using the statistical methods outlined in Appendix 2. The responses of the incumbents from the same base assigned to the same AFSC will be used for this validation. Further analysis and validation of the significantly demanding tasks will be made in later steps (I.4, I.5, I.6).
(e) Respondent Identification and AFSC Identification Sections.	The data will be serial number, duty station, duty AFSC, Duty squadron, and major air command.	The data will be used to ensure meeting sample sizing and stratification requirements.	The data will be obtained from military records and will be assumed valid.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNIT	DESCRIPTION OF DATA USE	VALIDATION OF DATA
Data necessary for survey sample sizing stratification and selection.	The data will be qualitative and unitless. The data type will be the number of 5 and 7 skill level individuals available per major air command, per Continental United States base within that command, per AFSC. The required sample sizing will be quantitative and the stratification will be qualitative. The sizing units will be number of individuals per AFSC, per base and per command. The stratification units will be per base, per mission, per geographical region.	The data will be used to select a sample of at least five individuals per AFSC, per base, and per command such that the sample will be stratified into the following important strata: 1. Incumbents from different Air Force bases having identical mission, 2. Incumbents from different bases having different missions to represent ATC, MAC, SAC, etc., and 3. Incumbents from bases from different geographical regions to account for varied environmental conditions. The objective of a stratified sample is to enable the contractor to perform standard statistical tests to test for: 1. Differences between AFSCs' requirements due to different methods and/or tools used in performing the same tasks, 2. Differences between AFSCs' requirements due to variation in equipment utilized, and 3. Differences in physical demands of tasks and/or stresses on the individual due to severe environmental conditions.	The data will be obtained from military records and will be assumed valid for this purpose.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
		This information will be useful in step I.6 when selecting performance criteria tasks which are representative of the demands of the AFSC.	
I.3 Selection of Tasks Which Have Significant Demands Tasks having significant physical demands based on the tabulated questionnaire results and statistical analyses of step I.2.	The type of data will be the incumbent ratings and the statistical analyses regarding differences in demand due to mission orientation, methods and practices of task performance, and environmental conditions. The format will be tabular. The units will be in terms of levels for the ratings: level 1, level 2, etc.	The data will be used to identify those tasks which are most likely to have significant physical demands and will therefore undergo a thorough task analysis (*step I.4*). *Those* having task demands equivalent to or greater than level 3 on the operational scale will be considered as having significant physical demands. *During this step, the contractor performing* the statistical analyses on the questionnaire results in I.2 will identify those AFSCs as well as their task which may have varied requirements because of the following factors: 1. Mission's orientation, 2. Methods and practices of task performance, and 3. Environmental conditions.	The demands for the tasks identified as having significant physical demands will be *verified* through the task analysis and quantification (steps I.4 and I.5). Furthermore, the questionnaire results will be checked for consistency in the responses.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
		If significant differences are found due to the above mentioned factors, the contractor will identify and record the differences in demand for use in the task analysis (I.4) and quantification (I.5) steps.	
I.4 Task Analyses to Develop Detailed Descriptions of AFSC Tasks A detailed description of those tasks identified as most likely to require significant demands	The type of data will be listings of task elements, narrative descriptions, and quantitative values from training manuals, operational and maintenance manuals, training films, task performance observations, and personal interviews. The format will vary but will include listings of the tasks and their elements, narrative, and quantitative values. The units for the quantitative values will be kg, meters, or their equivalent.	A detailed task analysis of each task identified in I.3 as likely to have significant physical demands will be performed in order to develop a quantifiable description of each task element. Task analyses will be accomplished through the use of available Air Force documentation; personal observations and personal interviews.	The task descriptions will be based on existing Air Force documentation supplemented by personal observation and personal interviews. Therefore, these data will be assumed valid.
I.5 AFSC Task Quantification in Physical Units			

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
Quantitative values for the significant demands of those tasks identified in step I.4 as having significant physical demands. Task quantification will be accomplished concurrently with the development of detailed task description.	Table 3, page 34, is a typical breakdown of the data which will be required. The anticipated type of data will be methods of work and estimates of physical values obtained from interviews of incumbents, actual task measurements, and listed values in Air Force documents. The data will be mostly quantitative values. Some aspects will be in qualitative form such as posture required. The units of measure will be times per minute, per hour, or per day, kg, meter, minutes, hours, number of helpers, degrees of angle, revolutions, ^{o}C, percent, kg-meter per minute, and kg-meter.	The data in Table 3 will be used to provide: 1. Complete method descriptions of elemental task performance including estimates of distances involved and movements made, 2. Complete quantitative listings of material, equipment, and tools used including size, shape, and weight, 3. Frequency of and time for task/element performance, 4. Estimates of forces required in the performance of each of the task elements both in magnitude and direction including any torquing requirements, 5. Body position (posture) during the performance of each element of the task and the segments of the body involved, and 6. The units of power needed to evaluate the dynamic components while the static components will be evaluated using force x time units.	Previous work reported by OMRD/HRL has shown that estimates provided by incumbents are accurate. This coupled with actual measurements of task demands will ensure validity of the data.
I.6 Selection of Performance Criteria Tasks (PCTs) Tasks which represent the significant physical demands of the types of activities	The type of data will be computed values of task demands AFSC.	The data will be used to develop a function 'G' to be used in a distribution of task demands representative of each AFSC, hence	The task description and quantification will be

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
(MMH, torquing, etc.) for each AFSC identified as having significant physically demanding tasks.	The percent time spent performing the task will be an estimate, provided by the incumbent, listed by task. The number of individuals performing these tasks will be an estimate obtained for each task.	task physical demands. The percent of individuals performing each task will be multiplied by the percentage of time spent on the task to arrive at the "weighted function 'G'." (Refer to Figure 7, page 40). Tasks which represent the significant physical demands of the AFSC, known as performance criteria tasks (PCTs) will be selected from distributions (the mode value $\pm$10%). These tasks will also be selected to represent the types of activities involved, e.g., manual materials handling, torquing, etc. These tasks will be used to identify the relevant physical capacities (step II.1) needed to perform these tasks. This in turn will provide the necessary information for selecting appropriate test batteries (steps II.1, II.3, IV.1, and IV.2).	rechecked through measured observations and interviews, once the PCT selections are made.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
Phase II. Strength Stamina Aptitude Tests II.1 Translate PCTs' Requirements into Physical Capacities Relevant to Successful Task Performance The types of physical capacities of individuals relevant to the successful performance of the tasks listed as the result of step 1.6.	The PCTs identified in Phase I will be used to determine relevant capacities. This will be accomplished through analysis of whether strength and/or stamina is required and the segments of the body involved. A computer analysis of these data will be conducted in order to identify the physical capacities relevant to successful task performance. The data that will be obtained in terms of the relevant capacities will not be any specific units but rather a list of specific capacities such as arm strength, leg strength, endurance, etc. (see Table 5, page 43, for more details).	The data will be used for the selection of the appropriate tests (II.3, IV.1, and IV.2) to be used for predicting task performance capability.	Validation of the data is inherent because of the systematic procedure used in translating the physical demands of the task into physical capacities used by the individual to perform those tasks. Translation of the tasks' physical demands to an individual's physical capacities will be dependent upon the expertise of the development contractor.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
II.2 Test Documentation and Inventory A list of tests that are relevant to the testing of the physical capacities tabulated in Table 5, page 43.	The type of data will be those listed in Appendix 4 and other standardized tests that may have been developed after the compilation of Appendix 4. The tests are based on measured observations. They will consist of a narrative description, an illustration, and quantitative values. The units will be number of tries per minute, minutes, beats per minute, meters, kg-meters per minute, and kg-meters or other appropriate units.	The data will be used to compile a list of tests which will most likely measure the relevant physical capacities of the individuals. The various test scoring procedures will be transformed so that they are compatible with the units of measure of the task demands. This will permit a further screening of the tests. Once compatible tests have been selected, then appropriate scoring procedures will be developed to make maximal use of tabular formats as opposed to requiring separate individual calculations. The information will then be used in step II.3.	These will be standardized tests which have been developed and validated for the testing of certain physical capacities. Additional validation of each test, by the contractor would be redundant.
II.3 Identify Candidate Tests for Inclusion within Test Battery Tests which will most likely be acceptable as a part of one or both physical test batteries.	The data type will be the proposed tests for inclusion in the initial test battery such as those listed in Table 6, page 47. The listings, and tabulated statistical results will be based on measured observations.	The results of the computer analysis conducted in step II.1 on the data concerning relevant physical capacities will be used to verify the selection of the likely tests listed in Table 6, page 47. If there are additional tests needed but not listed in this table, they will then be selected from the remaining inventory compiled in step II.2.	These will be standardized tests which have been developed and validated for the testing of certain physical capacities. Additional validation of each test by the contractor, would be redundant.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
	The units will include times per minute, meters, minutes, kg-meter per minute, kg-meter, kg, and meters.	The final selection of tests for inclusion in the list of candidate tests will take the following factors into consideration: 1. Similarity in physical capacities measured, 2. Administration time, 3. Ease of administration, 4. Scoring time, 5. Required administration training, 6. Test safety, 7. Equipment considerations, 8. Test accuracy and reliability, 9. AFEES and BMT schedule disruption, 10. Test recovery time, and 11. Test space. Final selection of the test will permit the ordering of test equipment to be used in the administration of the most likely tests (II.4) and the longitudinal validation (IV.5) in steps III.B and III.C.	
II.4 Administering of Likely Candidate Tests to Sample of Individuals Scores for the candidate tests which will be indicative of the task requirements.	The data will be measured observations quantified in units of kg-meters per minute or kg-meter. The results will be compiled in tabular form.	The tests identified and selected in step II.3 will be administered to a sample of new enlistees at BMT or a sample of incumbents depending on whether or not the PCTs can be simulated. The individuals in the tested sample will perform the PCT or a simulated task to determine their success performing	Data will be obtained from the previous step, therefore, it will be assumed valid.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
		the task. Based on these measurements and observations, minimum scores for successful performance in each AFSC will be established. These scores will then be used in steps IV.1 and IV.2 for the selection of the primary and secondary test batteries and the initial and final assignment criteria.	
II.5 Armed Forces Examination and Enlistment Station (AFEES) and Basic Military Training (BMT) Schedule Analyses AFEES and BMT schedule analyses	The schedules will be measured observations in tabular form with the relevant unit being hours.	The data will be analyzed to determine the optimum manner in which to include the additional procedures resulting from this project. The objective will be to minimize the adverse impacts. The data will be used in identifying the test location (IV.3) for the selection of the primary and secondary test batteries (IV.1, IV.2), the initial and final assignment criteria (IV.1, IV.2), and the longitudinal validation (IV.5).	It will be assumed that the provided schedules will reflect the actual activities of the AFEES and BMT. The recommended implementation of the resulting criteria (primary and secondary) will be checked to ensure that the testing does not take more than the allotted time and that the anticipated impacts on the schedules will be minimized. However, the final validity of that recommendation can only be accomplished by the actual implementation.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT: UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
Phase III. Defining Equipment for Strength Stamina Aptitude Tests and Task Measurement The requirements in each of the substeps of Phase III will be similar, hence the requirements for step III.A, III.B, and III.C have been addressed simultaneously. Equipment needed for: 1. The measurement of task demands (III.A), 2. The measurement of physical demands (III.B), and 3. The administration and validation of the primary and secondary test batteries (III.C).	The type of data (equipment) will be those items identified for measuring task demands and those identified for measuring physical capacities which have successfully passed a preliminary hazard analysis (DI-H-3278). The data will be qualitative. There will not be any units of measure but rather units of quantity such as the number of each equipment item required.	The equipment will be used for: 1. The measurement of task demands (I.5), 2. The measurement of individual's physical capacities (II.4), and 3. The longitudinal validation (IV.5).	The equipment used for task measurement and test administration will be standard equipment for these purposes. Such equipment has been used successfully by this contractor to measure typical task demands and individual capacities. Therefore, the chosen equipment will be assumed to accurately and reliably measure these variables.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA: FORMAT: UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
Phase IV. Finalization and Validation of the Assignment Criterion IV.1 Select Secondary Test Battery-Develop Final Assignment Criterion A test battery to be administered at the BMT and used to assign individuals to heavy jobs.	The selected PCTs will be performed by enlistees and successful and unsuccessful performers will be selected for a sample. This sample of enlistees will be measured for their physical capacities. Units of the data used will be strength in units of kg•min.; stamina in units of Kcal/min or equilavent; or power in units of kg meter/sec. or equilavent.	The data will be statistically analyzed to explore relationships that may exist between the variables. The techniques include regression and correlation analyses. Factor analysis will be used to identify the structure within the sets of these variables. The regression and correlation analyses will be used to determine the job's demand levels for which the enlistess will be best suited (or not suited). This will enable the contractor to determine which variables will be used in relating job demands to worker capability and thus give a preliminary identification of those tests that may be used as the "secondary test battery." The statistical procedure selected for the finalization of the test battery will be the discriminant analysis. An alternate will be the multivariate regression analysis. Appropriate percentiles and regions of the predicted description vector will then be identified for use in assigning persons to	Validation of the secondary battery and the final assignment criterion will be performed during the longitudinal validation (step IV.5).

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA: FORMAT: UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
		jobs having heavy physical demands. The tests will also be used to develop the primary test battery (step IV.2).	
IV.2 Selecting the Primary Test Battery and Developing the Initial Assignment Criterion A test battery to be administered at the various AFEES and used to assign individuals to heavy jobs.	Similar procedures as those which will be used in step IV.1 will be used here. The units will be kg-meter per sec, and kcal per minute, or kg-sec.	The data will be statistically analyzed similar to procedures used in step IV.1. From these analyses a primary test battery will be selected to be used at AFEES for assigning individuals to heavy jobs.	The primary test battery and the initial assignment criteria will be validated using the procedures described under the longitudinal validation (step IV.5).
IV.3 Location of Test Station during Validation Period The number and location of the test stations for the validation of the primary and secondary test batteries.	The type of data needed for this requirement will be the total number of test individuals needed for the validation procedures and the time allotted to complete the particular validation. The data will be quantitative in units of number of test individuals and days available.	The data will be used to determine the number and location of test stations to be used during the longitudinal validation step (IV.5).	The number of test individuals will be based on a statistical sampling plan. Hence, the number of individuals chosen will be an accurate estimate.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
IV.4 Conduct Field Studies to Investigate the Effect of Basic Military Training (BMT). Pre and post BMT measurements of physical capacities using the secondary test battery.	The type of data will be measured observations providing quantitative data on the physical capacity. The data will be in units of strength such as kg, kg sec.; or in units of stamina, such as kcal/min or equivalent; or in units of power, such as kg-meter/sec.	The data, pre-BMT and post-BMT measurements of physical capacities, will be tested to investigate whether or not there is a significant difference in the distribution of each capacity as reflected by the administration of the secondary test battery both before and after BMT. The standard 't' testing procedure will be used. The second test, an F-test, will be performed to determine whether or not individuals in specific capacity categories increase, remain unchanged, and/or decrease in all or some of their capacities. These tests will ensure that any changes in BMT are detected and accounted for in the assignment criteria.	The measurement procedures as well as the equipment used will be standardized; therefore, validity and reliability of the data will be assumed.
IV.5 Longitudinal Validation of the Assignment Criterion Data regarding the validity of the initial and final AFSC assignment criteria, as based on the primary and secondary test battery scores, to predict the suc-	The data will be statistically analyzed. It will be quantitative but expressed qualitatively.	A valid assignment criterion will be used by the Air Force to predict an individual's physical ability to perform tasks in an AFSC. Validity of the assignment criterion will be measured by their ability to accurately predict an individuals' physical ability to	The final assignment criterion will be considered valid if the misclassification error rates are 5 percent or less with a 95 percent statistical confidence. Thus, there shall

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA: FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
cess of individuals in various AFSCs.	There will not be any units of measure.	perform simulated PCTs. The appropriate prediction will be based on the classification to which an individual is assigned based on measured physical capacities. The data will be used in drafting the final report.	be two types of error that may be encountered. A type I error will be an error which occurs when a person is classified as category I, according to the current X-factor procedure, who in fact rightly belongs in category II or III. Similarly, a type II error occurs when a person is classified into category II, according to the current X-factor procedure, who rightly belongs in category I or II. A validation study will be made concerning the initial assignment criterion against the final assignment criterion. A similar procedure used to validate the final assignment criterion will be used here to validate the initial assignment criterion.

INFORMATION FLOW ANALYSIS (Cont.)

INFORMATION REQUIREMENTS (PROPOSED AND REQUIRED)	TYPE DATA; FORMAT; UNITS	DESCRIPTION OF DATA USE	VALIDATION OF DATA
IV.6 Document Primary and Secondary Batteries Documentation in detail of the primary and secondary batteries.	Tye type of data will be the test performed, the procedure used, the equipment used, instructions to the subjects, instructions to the technicians, methods of scoring and tabulation, and expected norms for each test. The data will be primarily qualitative with the exception of the expected test norms which will be quantitative. The units will be kg-meter per minute and kg-meter or equivalent.	The data will be used by the Air Force for administration of the primary and secondary test batteries. The data will be part of the final report.	Validation of the data will have been accomplished in step IV.5.

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